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THE
LARYNGOSCOPE.

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NUTRITION IN OPHTHALMOLOGY AND OTOLARYNGOLOGY.

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We now know that a lack of the right food produces pathologic changes in all tissues of the body. We never would have come to know this, however, simply by observing patients in daily practice. We are now aware that many patients are lacking in certain nutrients but we are unaware of the individual's need because the manifestations are usually so slight as to escape detection. The moderate and mild deficiencies rarely produce changes that we can recognize by inspection or study of the eye, ear, nose and throat. There are many parts of the world where gross changes have occurred and it is from the studies of such peoples that we have learned most. For years research workers have gone to such places as Labrador, Newfoundland and to certain sections in our Southern States, to study such obvious deficiencies. At this tragic period, millions are starved or are starving, in what recently were the realms of Hitler and Hirohito. These unhappy people are not concerned with the problem of a "balanced diet." Their difficulty is to find any food at all. It has been estimated that half of the German children under two years of age will die during this coming winter. Gross deficiencies are no doubt being studied by those in the medical services throughout Europe and the Orient. In the course of time information will become available. We have already learned that certain of the prisoners starved by the Germans

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and Japanese, although in a deplorable state, have been restored to a fair degree of health; this has required a variable period. In many, the degenerative changes produced by a lack of nourishment have gone so far that restoration is impossible.

In our editorial of 1942,[1] we attempted to estimate the actual weight of vitamins in the average human body. Although the exact amount of each vitamin is not yet determined, we know that all of the vitamins constitute an almost negligible part of the body weight. Realizing this, we commented on what a few pounds of vitamins might have meant to our defenders of Bataan and Corregidor. What we then feared turned out to be only too true.

What is the vitamin content of the body? The only reasonable approach to the problem is through the available information concerning the storage and optimal intake. It has been estimated that the average adult human body contains between 3 and 5 gm. of "C." Roughly, there are about 22 vitamins that are already chemically identified or partially so. Most of the other vitamins probably have even a smaller amount than "C." It is startling to realize what a very narrow margin there is between perfect health and a severe deficiency. For example, if the body has 4 gm. of "C" and should lose only 2 or 3 gm., scurvy would be present.

Lt. Col. Warren A. Wilson[2] was in the battles of Bataan and Corregidor. He was then captured and remained a prisoner throughout the war. His experience as Chief of the Eye, Ear, Nose and Throat Service at Cabanatuan Prison Camp and later, as American Commanding Officer of the Bilibid Prison reveals the stark reality of the ravages of an inadequate, monotonous diet to which otherwise normal, healthy Americans were subjected over a long period of time. In discussing vitamin deficiencies observed among Prisoners of War of the Japanese, it should be pointed out that many of the patients suffered from not only one but at times two, three or four of these various conditions collectively called avitaminoses. In addition, the majority of them had recurrent malaria and many had amebiasis. Of course the usual

infectious diseases were present; some had suffered from bacillary dysentery and there was even an epidemic of diphtheria. The observer has no hesitancy in saying that he has seen a number of patients who had both wet and dry beriberi, pellagra, scurvy and a tropical disease or two besides. It is interesting, however, that of patients on the same diet, one would have wet beriberi, the other dry; and both would have pellagra.

"A" Dificiencies.

Night blindness was the first evidence of deficiency observed at Corregidor. It was first noted in "spotters" at the anti-aircraft batteries, who had been accustomed to a two-hour shift. About the end of January 1942, roughly seven weeks after the war started, they found that they could see clearly for only about twenty minutes at a time during the day; at night their vision was even more impaired. Their diet had consisted principally of canned food with a minimal amount of meat, mostly cold storage, and rarely any fresh fruit or vegetables of any kind. Prophylactic vitamins were not available. This situation continued until all became captives in May 1942. This directed attention to a possible "A" deficiency. Early in the fall, numerous cases of xerophthalmia appeared, and many of these went on to the more serious condition, keratomalacia.

At this time very little "A" was available. Occasionally some could be secured from outside sources, but in very small amounts. In a hospital of over 2500 patients (American Prisoners of War), there was actually only one pint of cod liver oil for the entire group. This condition existed in December 1942, but fortunately at this time the diet was increased from two to three meals a day with an adequate supply of rice (usually and unfortunately polished) and many kinds of greens. In addition, there was a daily issue of meat — about fifty grams per man. This was carabao meat (native water buffalo) and is similar to beef. Also a small amount of Red Cross supplies, both food and medicine, arrived at this time; and the Japanese issued a five-gallon drum of "Sardinoil." The "A" content of this was not known, but it

probably was similar to cod liver oil which averages 6,000 units of "A" per tablespoon. Since a man can take only about three tablespoonfuls of this oil a day without becoming nauseated, it can be seen that the dosage was far from the 100,000 units therapeutically required. Nevertheless, this increase in nutriment and medicine, limited as it was, resulted in a noticeable general improvement in the clinical condition of these patients. In fact, after sixty days there was scarcely any evidence of severe "A" deficiency in the camp, with the exception of night blindness which continued throughout the duration of the imprisonment.

Although night blindness was the first deficiency disease observed in this campaign, and although it has been discussed under the section dealing with "A," it was probably not an "A" shortage *per se*. There are four vitamins essential to the metabolism of the visual purple.[3] Since "A" has been demonstrated to be stored as long as two years in the liver and other tissues, it is unlikely that the night blindness was due to a lack of "A," but more probably to a lack of some other factors — quite possibly "B_2," whose storage in the body is soon exhausted when adequate intake is not maintained. Confirming this, it should be pointed out that night blindness, observed in the prison camps at later periods (1944) when sufficient "A" was present to be prescribed in dosages of 100,000 units a day, was not improved — much less cured.

B-Complex Deficiencies

In April of 1942, the first cases of so-called wet beriberi were seen. The main clinical manifestation was a pitting edema of the feet and ankles which later progressed up the legs and the rest of the body. At the time, the writer was an attending surgeon at Corregidor, and observed these cases for a period of nearly two months. A survey was made of all the enlisted men of the medical detachment. Between 25 and 50 per cent had edema of the lower extremities to a greater or lesser extent. Blood chemistry was not available, but urinalyses were run, including microscopic examinations. There were no positive findings, with the exception of low

specific gravity in some cases; this was not consistently present even when fluid volume intake and output were measured. Nearly all personnel complained of frequency of urination and nocturia, averaging five to seven times. The diet of all personnel at this time consisted of two, later increased to three, moderate sized meals of unpolished rice daily, with only a tablespoonful of corned beef or corned beef hash each day. Many of these patients received 50 mgs. of "B_1" by injection daily during this two-months period. Others received 5 to 10 mgs. by mouth. Little of the B-Complex was available except a limited supply of brewer's yeast tablets. Under this treatment, it can definitely be stated that no clinical improvement was observed.

By the summer of 1942, many cases of wet beriberi were developing. Some of these patients were edematous literally from the soles of their feet to the tops of their heads. If a patient was lying on his right side, the lower side of his face would balloon out until it was almost twice the normal size; if he was then turned over, the same thing would happen to the opposite side within fifteen minutes. The edema could be reduced temporarily by giving human blood plasma two or three times a day; but it could not be controlled unless adequate protein was provided in the diet. When available, "B_1" was given by injection or by mouth. It was not apparently helpful but it may have been of some aid in cases of beriberi heart disease. There was no electrocardiograph; so the diagnosis of the heart condition was based on the physical findings of faint heart tones and rapid pulse rate. A number of these patients succumbed either to wet beriberi *per se* or to berberi heart disease. For a period of about six months beginning in the fall of 1942, the prison camps at both Cabanatuan and Bilibid produced their own brewer's yeast. The original culture was obtained from a brewery in Manila (Japanese controlled) and was nurtured on rice and sugar, both of which were available in reasonable quantities at the time. The yeast was prescribed in a dosage of one tablespoonful per man per day prophylactically, or two tablespoonfuls or more therapeutically. The supply was limited and it was seldom that larger doses could be given.

Although there was no obvious benefit derived from yeast therapy, the prophylactic value may have been greater than was realized at the time. At the end of 1942, when the diet was increased and a small amount of medicine was available, most of the serious cases recovered; however, pitting edema of the lower extremities persisted throughout the term of imprisonment, afflicting individuals in proportion to the lack of protein in the diet. When the diet became very low in caloric value and practically meat-free (by the fall of 1944), about 90 per cent of all personnel had pitting edema — although at this time "B_1" and most of the B-Complex factors were available in adequate amounts. From the experiences at the various camps, it was evident that no marked improvement was ever seen when vitamins were prescribed without an adequate diet.

This observation tends to confirm what we stated in our 1943 editorial[4] concerning the nutritional importance of raw materials: "Vitamins are activators. In recent years vitamins have so filled the center of the stage as to crowd into the background the essential raw materials, which constitute the body. These raw materials are constantly suffering wear and tear, requiring replacement. Activators — whether they be vitamins from without or endocrines from within the body — provide no raw materials. The vitamins and endocrines are valueless except as activators. Raw materials and their products are also valueless without the activators."

It is interesting to note that at Christmas time 1943, some Red Cross food boxes were received. One of these boxes contained approximately enough food for one man for a week. Some patients who consumed an entire box within a few days, were apparently cured of their edema. When they returned to a diet of polished rice three times a day with the addition of greens and only occasional meat, the edema recurred.

Dry Beriberi.

This condition first appeared in the summer of 1942. It was characterized by peripheral neuritis primarily of the legs but occasionally of the arms and hands. These patients com-

plained of burning pains in their feet and legs, day and night. Many of them could not sleep and the medical Officer of the Day would often find them sitting up in their bunks rubbing their feet, or sitting outside warming them over the fire at the camp kitchen. With the exception of the gait, there were no definite clinical findings. Some revealed hypoactive and others hyperactive reflexes. All had paresthesias to a varying degree. However, the majority of these cases that progressed to a serious state developed a rather typical gait which made it appear that they were walking on hot coals. Colloquially they were known as the "hot foot cases, and later there was a "hot foot" board formed to survey these cases. Even when the diet was increased at the end of 1942, there was no appreciable improvement, nor did the brewer's yeast relieve them. Aspirin and the usual analgesics did not relieve the pain and even morphine was not of any great use, unless the dosage was sufficient to produce narcosis.

At Cabanatuan about 750 patients suffered from dry beriberi at this period — the total personnel was a little under 6,000. "B_1" when administered by mouth or by injection, especially the latter, seemed to ameliorate the condition somewhat; but there may have been a psychologic element because vitamins were so valuable and so scarce. A year later (Christmas 1943) when Red Cross drugs were received in adequate amounts, large quantities of "B_1" were given to all of these patients. The usual dosage was 50 mgs. per man per day of the "B_1" in addition to some of the other factors of the B-Complex, such as niacin and riboflavin, or multiple vitamins or brewer's yeast. This treatment seemed to produce an improvement in most cases but could not be considered curative. Presumably this was because these cases were so far advanced by this time; many had suffered from this condition for over a year and a half. No deaths were observed from dry beriberi, but many were so run down that they died of intercurrent conditions, such as dysentery. Although an adequate number of cases is not available it seems that the few seen since their return to the United States and who have had a high vitamin, high caloric diet for about six months, now have scarcely any symptoms of

their peripheral neuritis. These patients had suffered from the condition for about two and a half years as Prisoners of War.

Retrobulbar Neuritis.

In the late summer of 1942, the writer began to see cases that were subsequently diagnosed as retrobulbar neuritis, or more commonly, nutritional amblyopia. The patients came to the dispensary complaining of blurring of vision, orbital and retrobulbar pain, and usually of redness and tearing. The diagnosis was missed at first because there were no findings in the eyegrounds. At the time a Snellen chart was not available, nor was there a perimeter or a tangent screen. Later, when a Snellen chart was improvised, it was found that these patients had definite loss of visual acuity. When visual field examinations had also been devised, a diagnosis of retrobulbar neuritis was made clear.

These patients were treated, when possible, with "B_1" and parts of the B-Complex. As has been stated above, this was a very scarce commodity at the time. If a case was diagnosed early, it is surprising what benefit was derived from a hundred 5 mg. tablets of "B_1" taken by mouth — in conjunction with a reasonably adequate diet. By the beginning of 1944 when there were sufficient vitamins in the camp, 50 mgs. of "B_1" by injection were given daily over a period of two or three months or more. In addition, at least one multiple vitamin capsule was given each day to supply some part of the B-Complex, and in many cases a larger dose was given. Some patients received 10 to 20 mgs. of "B_1" by mouth either alone or in conjunction with the "B_1" injections. None of this treatment seemed to be of any benefit and by this time definite optic atrophy was observed in many instances; all of these cases eventually showed some evidence of atrophy. As a result, although no cases of total blindness were observed or heard about, many of these individuals have suffered permanent impairment of vision. This seems to be the fate of the few that have been examined since returning to the United States, in spite of an adequate diet and large amounts of vitamins.

Ear, Nose and Throat Conditions.

A dozen or more cases with apparently a nerve type of deafness were observed at Cabanatuan. The diagnosis was based on obvious clinical findings and the usual simple hearing tests. Neither tuning forks nor audiometers were available. It was considered to be a perceptive type of deafness, however, because they heard their own voices poorly and talked loudly in order to compensate. In most instances, these patients suffered from other forms of "B" deficiency, such as dry beriberi and retrobulbar neuritis. Most of them were taking quinine in varying amounts; all had also been exposed to heavy firing, either artillery barrage or bombing or both. Consequently, no definite diagnosis of nutritional deafness could be made nor any positive conclusions drawn.

No other ear, nose and throat conditions that could be considered as due to vitamin deficiencies were observed. Although hundreds of cases were examined, no changes in the mucous membranes of the nose or throat were seen, with the exception of the stomatitis and glossitis seen in conjunction with pellagra and scurvy.

"C" Deficiencies.

During the summer of 1942 there were numerous cases of scurvy, recognizable by bleeding, spongy gums and also by subperiosteal hemorrhages along the bones of the arms and legs. Many had a scaly dermatitis of the scrotum; whether this was a true characteristic of the disease or was possibly related to ariboflavinosis, cannot be stated. It was generally considered to be due to scurvy and responded to citrus therapy. The specific vitamin for either condition was lacking. At this time there was often a difference of opinion as to diagnosis, between the members of the medical and the dental staffs. Many patients did not possess tooth brushes, much less tooth paste or other drugs for care of the mouth. Obviously cases of gingivitis and pyorrhea might exist in patients who were actually suffering from scurvy. If, however, the patient had bleeding gums and also subperiosteal hemorrhages, it was assumed that the condition was scurvy.

Again, unfortunately, vitamins were available only in negligible amounts. A native fruit was prescribed — a type of tropical lime called calamansi. This fruit was not obtainable in large quantities but when the individual was able to get even a few a day, startling results were often seen within a week or two. When more food became available at the end of 1942, scurvy disappeared entirely from the camp within a few weeks.

Pellagra.

Pellagra was first observed in the summer of 1942. It was manifested by dermatitis of the back of the hands and arms and about the neck, and in many cases over most of the body, since in the tropics the majority of Americans were wearing only shorts and were thus exposed to prolonged sunlight. The observer has seen a number of cases revealing the four D's of pellagra — Dermatitis, Diarrhea, Dementia and Death. Dermatitis was, of course, the most frequent sign. Many people were dying from dysentery which could not be typed for lack of laboratory facilities; however, it was felt that many with pellagra had probably gone on to death from pellagrinous diarrhea. Dementia, while not common, was seen in a number of cases. As in all other deficiency conditions, there was a markedly inadequate diet and of course little or no medicine. Occasionally some niacin would come into camp, such as the small amount with the Red Cross medicine received at Christmas time of 1942. With this medicine and the increase in foods during this period, pellagra more or less disappeared. It is interesting to note that in the period of six months during which many of these patients had suffered from pellagra, the condition became so chronic that it persisted throughout their term of imprisonment. Niacinamide became available in adequate quantities by the end of 1943 and it was necessary to continue treatment in many of these chronic cases throughout 1944. If the drug was stopped for a few days or more, pellagra would again become manifest and in many the skin lesions were not cured but only controlled. In the fall of 1944, a patient whom the writer knew expired; he had been receiving 100 mgs. of nia-

cinamide a day for over three months, and prior to that time had received much larger doses. He had all of the symptoms of pellagra — generalized dermatitis, diarrhea and dementia. He was only 22 years old but had the facies of a man in his sixties. The pellagrinous condition had existed for over two years and the writer believes that he succumbed to the disease.

Glossitis was invariably present in these patients; but in regard to the stomatitis it should be emphasized that many of these patients were suffering at the same time from scurvy with its related gingivitis. In addition there was neglect of mouth hygiene. Therefore it was often difficult to say that the stomatitis was due to the lack of any single vitamin.

Ariboflavinosis.

During the summer and fall of 1942, several cases of ariboflavinosis were diagnosed. These patients revealed the oily scaling on the backs of the ears, the alae of the nose and the corners of the mouth. In 1943 it was felt that some of the cases of conjunctivitis and blepharo-conjunctivitis were possibly manifestations of this deficiency. When general nutrition was improved at the end of 1942, all signs of ariboflavinosis disappeared except the ocular. Riboflavin, like the other vitamins, was always at a premium and it was not until the beginning of 1944 that any considerable amount was available. As very few cases of a definite deficiency of this type were then present, the drug was used in conjunction with other factors of the B-Complex in treating beriberi.

Frank B. Baldwin, M.D.,[5] was on the medical staff at Santo Tomas University, Manila, P. I., where the majority of the civilians (mainly American and British) were interned from January 1942 until February 1945. According to Dr. Baldwin, the internees suffered very little physical discomfort during 1942 and 1943 since there was living space for all, sports were available within limits, and a reasonable diet was provided. In addition to the rice, greens, other vegetables and occasional meat provided by the Japanese, the internees were able to buy a considerable amount of their

food through Chinese and Filipino merchants in Manila. Among the foodstuffs purchased were chicken, beef, Brahma steer, liver, canned meat, various kinds of beans, sugar and many fruits such as bananas, papayas, oranges and calamansis (native type of limes).

As in all camps, drugs were at a premium until late in 1943 when an adequate supply was received from the American Red Cross — but up to this time there had been no serious need for them. Beginning in March 1944, there was a marked reduction in the quantity and quality of food available. The Japanese administration not only reduced the issue, but forbade outside purchases except for occasional periods. Besides, by this time, the general situation in the Philippine Archipelago was deplorable. The average Filipino was himself on a starvation diet and food of any type was extremely scarce. Inflation was so great that the always limited and now depleted funds of the internees had little or no purchasing power. The Japanese Army had confiscated much of the rice crop — and it must be remembered that the Philippines produced only 80 per cent of their normal rice requirement prior to the war.

On a diet that was perhaps 1800 calories daily at the beginning of the year and which dropped to 1000 calories or less per individual daily by the end of the year, it is not surprising that deficiency diseases developed. Again it must be pointed out that these deficiencies occurred when the diet was inadequate in calories and lacking in two essentials — proteins and fats. This occurred even though each individual was receiving at least one multiple vitamin capsule daily — and many, brewer's yeast also. Any person revealing definite symptoms received in addition whatever vitamin was indicated. Even at that, the vitamins did not suffice in the absence of adequate "raw materials."

In sharp contrast to the conditions prevailing in the camps for Prisoners of War, where all personnel had received a deficient diet from the beginning of 1942, and where conditions became so deplorable by the summer of 1942 that all known deficiency diseases were rampant, the civilian

internees were unaffected until the spring of 1944. The most pronounced condition which then developed was wet beriberi. Dr. Baldwin and others of the medical staff were of the same opinion as the army and navy medical officers that this syndrome is primarily a hypoproteinemia. They also saw patients with severe generalized edema who responded to human blood plasma given intravenously but whose edema could not be controlled unless they received enough protein — regardless of the amount of "B_1" or B Complex, whether orally or by injection. This group also revealed that most of its members had more or less edema by February 1945 when rescued by the American forces. Of the other deficiency diseases, there were a few cases of dry beriberi, an occasional case of scurvy (and this was usually in a person who refused to take his vitamins), and a few pellagra cases of varying degree. Many individuals developed mouth lesions which did not reveal a definite clinical entity.

From the standpoint of the medical observer, Santo Tomas presented more in relation to general medicine than just a clinic for the study of vitamin deficiency. The internees were comparable to an American town with a population of 3700 men, women and children. Mortality, which was negligible in 1942 and 1943, increased markedly in 1944 but in general the children survived as well as the adults of the third to fifth decade. The older group succumbed to the ravages of starvation, with intercurrent infections frequently being the immediate cause of death. This is in contrast to the Prisoner of War Camps where the younger men showed the highest mortality.

When so much is being written in the medical literature about psychosomatic medicine, the mental factor should certainly be considered. Dr. Baldwin emphasized this point repeatedly. The internees faced a number of problems which were cause for great anxiety. There was the separation of families — some members in other parts of the world, some in other prison camps. There was the basic fact that no one ever cares to be incarcerated; confinement frequently caused intense moodiness. Some individuals simply do not adapt

themselves to an environment in which they cannot come and go as they please. There were financial worries, not only for the future concerning such matters as loss of investments made in the Philippines, but also immediate worry about funds to purchase the necessities of life. Of course, there was always the fear of their captors and what their eventual fate might be. In contrast, the prisoners of war who suffered much more physically and who also included individuals who could not adapt themselves to this type of environment, in many ways had a different psychologic approach from that of the civilian internees. The members of the armed forces had all been in a rigorous combat zone and had learned to accept the fortunes of war, of which being a prisoner was simply one.

In relation to the general diseases mentioned above, hypotension seemed to be the rule at Santo Tomas and perhaps was a big factor in preventing more deaths from vascular causes. When the stress and strain of normal civilian life is removed, as it certainly was in many ways in prison camp, it is understandable that blood pressures would fall. Of course, the limited diet reduced many normally overweight people and while we cannot say that without obesity there is no hypertension, still when the two happen concurrently, it has always been a medical axiom that a reducing diet must be the first phase of treatment. A more remarkable observation was seen in connection with diabetis mellitis. Many diabetics improved, their insulin intake was reduced or completely stopped and the many complications of the disease failed to develop — and this in spite of such a high carbohydrate diet over a period of three years. Dr. Baldwin is inclined to attribute this to a reducing diet. Overeating does not occur in prison camps. Also a reasonable amount of exercise was forced on all personnel. There was no transportation available and the various activities of the camp necessitated that all walk to and from the many buildings of a large university campus.

Constipation, which rarely occurred in the Prisoners of War Camps where diarrheas and dysenteries of all types were

common, was a disturbing condition among civilian internees. This was apparently caused by the low bulk of the diet. It was usual to have a bowel movement only every three or four days; at times some individuals would go as long as two weeks. The Eskimos are said to average a passage about once in two weeks — on a high fat, high protein diet. In contrast, the internees were on a high carbohydrate diet.

As a tribute to Dr. Baldwin, a special Menu card was prepared for his birthday in January 1945. It reads — Breakfast, corn meal mush, coconut milk, copra meal cake; Lunch, small scoop rice, water; Dinner, ladle rice, dipper sauce. Under the noses of the Japanese, the American touch is evident in the final lines — Santo Tomas INTERMENT Camp.

Arthur H. Evans[6] was interned at Santo Tomas in January 1942. There were between 3000 and 4000 Americans and British Civilian Internees in the camp at that time. From January to May 1942, Mr. Evans supervised the procurement of food supplies obtained from outside the camp. These supplies greatly augmented the food issued by the Japanese. In fact many internees with resources of cash/or credit ate little of the Japanese issue food during 1942 and 1943.

The food problem was not difficult for the first two years of imprisonment. A few products which Americans consider desirable, although not necessarily essential, were lacking. A fair diet was within the reach of everyone. The foods lacking included butter, fresh milk and cream, wheat flour and potatoes. On the other hand, a reasonable supply of meat was obtained; there was some milk, both evaporated and powdered, available for children and hospital patients; there were many kinds of fruits, a fair diversity of vegetables, and camotes (native sweet potatoes) and rice. Beginning in March 1944, however, purchase of foodstuffs from outside was restricted by the Japanese; and coincidentally, their own food issue became very limited. As a result, most of the internees were now forced to subsist on a diet of 1500 calories or less with a very low fat content and almost negligible protein. The protein intake, with the exception of what little is contained in the rice, was obtained through various types

of beans and approximately one ounce per individual per day of fish. The fats were obtained mainly from coconuts.

Mr. Evans, in addition to his procurement activities, for a time supervised the preparation of food for the camp. He improvised a very ingenious method of extracting the food value from coconuts. An electric washing machine was utilized. The central container was perforated with numerous small apertures about 1/64th of an inch in diameter. The coconut meat was ground very small, put in this central container and boiling water added. When the machine was put in motion the coconut milk was thrown to the outside of the container by centrifugal force. The viscous liquid obtained was then issued to each individual to pour over his morning lugao (rice mush) which not only made it more palatable because of the flavor and sweetness of the coconut, but added some of the much needed fat content to the diet. In a prison camp, occidentals soon learn the oriental system of utilizing every available product. The remnants of the coconut meat in the inner container of the washing machine were subjected to a pressing process and the residual coconut oil was used to make soap. In the confined and none too hygienic environment of a prison camp, one cannot overstress the old adage about cleanliness and Godliness. The crude soap that these Americans manufactured was undoubtedly a great factor in preventing the spread of dysentery and other contagious diseases because it enabled them to wash their dishes, cooking utensils and clothes.

Mr. Evans himself survived his ordeal with no other ill effect than the marked loss of weight which all internees showed. While personal cleanliness is perhaps a factor in preventing contagious disease, Mr. Evans himself suffered from no deficiency disease. The regime which he followed is interesting because he he is not a physician but was simply an ingenious American. From March 1944 to February 1945, he fortified himself with certain minerals. He took an iron capsule daily, added a drop of iodine to his drinking water, but was unable to obtain any sulphur or calcium. He had two 8-ounce bottles of cod liver oil and he took one spoonful a

week while it lasted; this augmented his "A" and "D" supply.

Some, but not all, of the internees had a supply of yeast tablets; Mr. Evans had none. He supervised the manufacture of yeast which had been obtained originally from a local brewery and then was nurtured on very ripe bananas, sugar and camotes. He took a tablespoonful a day of this. A man of Mr. Evans' size would ordinarily require about 3000 calories a day; but during this last 10 months he never received over 1500 calories a day, and the last few months he was below 1000 calories. At 1500 calories one can exist if he is leading a very quiet life and expending very little energy; but unfortunately the Japanese required two hours a day of manual labor from all men below 55 years of age. Women under 50 were also required to do camp work. In spite of the severe weight loss and low caloric diet, Mr. Evans did an unusual thing — he continued to do calisthenics in order to keep his muscles conditioned, because he felt that an actual physical fight or perhaps some strenuous ordeal, such as a long hike, might be necessary before his release. He worked up to 65 or 70 push-ups a day and in addition did both pull-ups and sit-ups. At 117 pounds there is not so much weight to push up or pull up as at his normal 170 pounds; still with such a low caloric intake it is amazing that he was able to follow this strenuous physical regime. As he said himself, he was fast and he was hard, but he doubted if he could have "gone more than three rounds."

In this, our sixth editorial on this subject, we have been asked to restate our "embryologic approach to therapy," in an up-to-date summary. For some years the writers have been impressed with the importance of observing tissue, as such. The tissues of the body which are most easily observed are those of the skin, eye, ear, nose and throat. Studies of nutrition emphasize the need of keeping constantly in mind that tissue is the prime consideration — in either health or disease. It is the ophthalmologist and otolaryngologist who have an unusual opportunity to study tissue — not only by direct observation but by precision measurements which reveal the condition of the tissues that one cannot actually see.

Is it possible for us to learn the nature of a deficiency by study of the actual lesions that a patient shows? Can we find a rational approach? Perhaps we can — through embryology.

If better food, properly cooked, is to improve the human race, the first and perhaps the most important consideration is the chemistry of the fetus. Like all living things, whether animals or plants, the embryo requires the vitamins; in fact, only by providing vitamins in an adequate amount can the mother expect to have a normal baby. The "embryologic approach" to therapy is based on the following concept: Not only does the embryo require vitamins, but each germ layer makes a special demand for those particular vitamins that are necessary for its own development; the Ectoderm demands "A" and the B-Complex; the Mesoderm demands "C" and "D"; and the Entoderm demands "A" and B-Complex. If the pregnant woman lacks a certain vitamin, one germ layer of the embryo will be particularly affected; for example, if "D" is lacking, the Mesoderm is especially deprived — and the bones of the baby, derived from the Mesoderm, will be poorly developed at birth. Throughout life the derivatives of each germ layer continue to demand the same vitamins that meet its special needs.

In brief, this concept might be expressed as follows: *1.* Each tissue has need of many vitamins. *2.* Although each vitamin affects various tissues, it appears that a special relationship exists between vitamin and germ layer. *3.* It seems that each germ layer demands an oil-soluble and a water-soluble vitamin. The Ectoderm requires "A" (oil-soluble) and the B-Complex (water-soluble); the Mesoderm requires "C" (water-soluble) and "D" (oil-soluble); the Entoderm requires "A" (oil-soluble) and the B-Complex (water-soluble). *4.* The Ectoderm and Entoderm seem to have a common need in that they demand the same vitamins — "A" and the B-Complex. *5.* The Mesoderm requires "C" for the development of connective tissue and "D" for the development of bony tissue.

Specifically, the Ectoderm (surface) contributes the following structures to the Eye: The epithelium of lids, cilia, Meibomian glands, lacrimal apparatus, conjunctiva, cornea, and the lens. The Ectoderm (neural) contributes the optic nerve (neuroglial and nervous elements), the epithelium covering the ciliary processes, the retina (with pigment layer), the pigmented epithelium covering posterior surface of iris, the sphincter and dilator muscles of the iris. (All muscles of the body derive from Mesoderm except the iris muscle and the tiny muscles that "raise the hair.") The Mesoderm contributes the following structures to the eye: Stroma of the cornea, the stroma of the iris, the chorioid, the sclera, the ciliary and extraocular muscles, the optic nerve sheath, and the aqueous. The Entoderm contributes no structures to the Eye.

The Ectoderm (surface) contributes the following structures to the Ear: The skin of the auricle and external canal and the epithelium of the internal ear both cochlear and vestibular. The Ectoderm (neural) contributes the nervous structures of the internal ear. The Mesoderm contributes the supporting structures, muscles, bone and cartilage of the middle ear and Eustachian tube. The Entoderm contributes the epithelium of the middle ear (from the first pair of pharyngeal pouches), the epithelium of the middle ear (from the first pair of pharyngeal pouches), the epithelium of the ossicles and the epithelium of the Eustachian tube.

The Ectoderm contributes the following structures to the nose and the mouth: Epithelium, including the olfactory, the mucous glands, the enamel of the teeth and the salivary glands. The Mesoderm contributes: The cavernous structures of the turbinates and all supporting tissues, the muscles and bones, tonsils and adenoids and the dentine and cementum of the teeth. The epithelium of the pharynx and larynx is derived from the Endoterm.

The attitude of the writers toward this embryologic concept remains one of caution. This concept is important, if true, because it offers a direct approach to therapy, which we have been using more and more, in routine practice — instead of

putting our entire trust in the gospel of the "medical missionary," the detail man. Far from assuming the dependability of the embryologic approach, efforts should be continued to unearth fallacies in it. So far experimental work and clinical reports seem to confirm it; but every attempt should be made to discover discrepancies or exceptions.

One of the daily problems in otolaryngology is susceptibility to "colds." The usual practice has been to attack local conditions in the sinuses or tonsils, by local measures or surgery; or to "try out" vaccines — either by needle or mouth. It is neither necessary nor wise to abandon old procedures; but we are coming to think more in terms of two systemic factors — nutrition and fatigue. Patients often complain of "catching cold all the time." Inquiry may reveal exhaustion from overwork; and relief often comes from regulation of habits — or a vacation. In this connection one should bear in mind what Jonathan Wright used to say: "The tubercle bacillus is no less — and no more — the cause of tuberculosis than is the skin the cause of dermatitis. Without the tubercle bacillus one does not have tuberculosis; without one's skin one does not have – – – but need I carry this thought further?"

One important clinical problem has been the high cost of many indispensable pharmaceuticals. The reasons for this are not easy to unravel. An element of secrecy brings up the thought expressed in a lay magazine[7] — Lin Yutang is quoted as saying that it sometimes seems we do not need the Four Freedoms, but only one Freedom — Freedom from Humbug. It is the impression of the writers that patients who simply must have these pharmaceuticals should make it a point to be well-to-do. Medical journals have failed to take up this matter — until recently when the *Jour. A. M. A.*[8] reports that, following a warning by the Assistant United States Attorney-General that drug cartels and monopolies have seriously affected the national health, a House sub-committee has proposed war on these practices.

In our 1940 editorial[9] we proposed the principle, "No deficiency—no cure." Govier[10] now says that, to many, the use of

vitamins in the therapy of conditions other than those produced by avitaminosis is, on the face of it, absurd. However, he finds a definite reason for using vitamins—and probably in fairly large quantities — in conditions associated with *anoxia* of various types. Tonutti and Wallraff[11] showed that the liver of a "B_1"-deficient mouse cannot store glycogen. Blotevogel and Tonutti[12] have used "B_1" as an apparently successful treatment for severe burns. On the basis of these results Govier induced shock in dogs by fractional bleeding. "B_1" was administered to half of them; these dogs lived longer than those not receiving "B_1." As a deficiency of "B_1" causes increase of pyruvic acid in the blood, pyruvate determinations were made on a number of animals in shock. The pyruvate level rose from 1-2 to 4-5 — a level actually higher than that seen in most cases of beriberi. Thus it would appear either that shock produced a "B_1" deficiency or that the "B_1" became incapable of functioning in a normal manner. Some dogs were then made "B_1"-deficient, wheras others received stock diet fortified with "B_1"; the difference in ease of production of shock was very striking. The "B_1"-deficient dogs went into shock after less bleeding; the blood pressure dropped precipitously and remained low, whereas the pressure of the "B_1"-fortified dogs showed a constant tendency to rise. Copious intestinal hemorrhages occurred in 86 per cent of the "B_1"-deficient dogs—but not at all in the "B_1"-fortified group; in fact the paucity of changes occurring in the fortified dogs made it appear that these dogs did not go into shock at all. Dogs with normal "B_1" levels in the plasma were benefited by receiving extra "B_1." Govier suggests as an explanation of this the curious fact that the "B_1" in the tissues of the animals became ineffective — that, although available, it could not be utilized by the cells. When shock anoxia upsets the normal equilibrium whereby phosphorus complements the "B_1" activity, then the "B_1" may be available but not utilizable. Thus these animals, although well supplied with "B_1," were actually "B_1"-deficient since it was in a form which could not be used by the cell. In those cases, large doses of "B_1" were required in order to raise the intracellular content of "B_1."

There is a sharp divergence of opinion as to the incidence of deficiencies. On the one hand, Dann and Darby[13] consider that, although mild deficiency disease may be detected by conjunctival changes, angular stomatitis or changes in appearance of the tongue — such signs are not pathognomonic of specific deficiency. At the present time there is very little severe deficiency disease in the United States; the only one to reach epidemic proportions is pellagra. An editorial[14] makes a sarcastic comment on this point: We have seen the American people spending hundreds of millions of dollars for vitamins. People have suddenly felt the need of vitamins, believing that everyone, to be healthy, must supplement his daily diet with a liberal supply. One wonders how our forefathers, who discovered and developed this country, ever survived the hardships of their pioneer days without vitamin pills. In the same vein, an effort to determine the effects, if any, of various vitamins on normal persons, Ruffin and Cayer[15] studied five groups of medical students and technicians — 40 in each group. The vitamin tablets contained 2500 units of "A," 200 units of "D," 1 mg. of "B_1," 1.5 mg. of "B_2," 2.75 mg. of "C" and 10 mg. of nicotinamide. The first group received three vitamin tablets daily plus 1.5 gm. of 1:20 liver extract. The second group received three vitamin tablets daily plus 1.5 gm. of dried yeast extract. The third group received three vitamin tablets daily, plus placebos of dextrose. The fourth group received three vitamin tablets daily. The fifth received dextrose placebos only. One out of seven showed improved appetite and energy — equally in all groups. One out of thirty-six showed improved general health — equally in all groups. Slight increase in weight was noted in the first, fourth and fifth group — none in the other groups. The conclusion was that vitamins supplementing average American diet have no effect on apparently normal persons.

On the contrary, Moose[16] notes in the recent bulletin of the National Research Council that over two-thirds of the population in the United States are subsisting on faulty diet, and have nutritional deficiencies in some degree. One of the main reasons for this situation is the excessive use of refined

white sugar, pure sucrose. When 20 per cent of a man's diet is "diluted" it is logical to conclude that his tissues and physical strength are likewise "diluted." White flour is another "refined" food which contributes largely to the faulty diet. Sugar and white flour form the pastries of various kinds, while sugar alone goes into the sweetened carbonated beverages and candies. If a man eats himself into a disease, effective therapy requires that he be fed out of the disease. The physical and chemical constitution of the patient's tissues is so altered with improved nutrition that not only is recovery hastened and relapse prevented but also recurrence is less likely to occur.

To Wilbur[17] it seems that doctors have had less interest in health than in disease, and consequently have paid little attention to nutrition — until they became aware that diseases often result from nutritional deficiency. Good nutrition and good health are inseparable; the doctor should be an expert in both. In an effort to bring this to the attention of physicians, Wilbur arranged a symposium by a group of authorities on the matter. He himself defines nutritional deficiency as a condition which arises when man or animal fails to obtain, or utilize, a physiologically indispensable amount of one or more of the essential nutrients. With continued tissue depletion a "biochemical lesion" may develop. Greater deficiency will lead to functional changes in the tissues and subsequently to anatomic lesions. While the distinction between the stages of deficiency is not always definite, this concept is of value in understanding degrees of deficiency as well as the rapid or slow response to treatment. Biochemical lesion and functional changes may be reversed very rapidly following treatment, whereas anatomic lesions are only slowly or incompletely reversed. The most readily appreciated symptoms of an "A" deficiency have to do with changes in the eyes. The symptoms of mild deficiency consist principally of inability to see clearly in dusky light and conjunctival irritation. Photophobia or blepharitis may be indicative of this condition. A therapeutic test of 25,000-75,000 units of "A" daily for a week or two should produce prompt decrease in

early signs of an "A" deficiency. Definitely established skin lesions may require more prolonged therapy. Deficiency of "B_1" may manifest itself not only in actual nerve lesions such as peripheral neuritis and paresthesias but also in various psychic disturbances — from irritability to insomnia. "B_1" deficiency may be detected through its content in the urine and blood; by determination of the pyruvic and lactic acid values of the blood; by measuring its excretion in the urine after a test dose; or by a therapeutic test — 10 mg. several times daily over 5 to 14 days should result in prompt improvement or disappearance of nervous symptoms. Since deficiencies of the components of the B-Complex almost always coexist, some form of the B-Complex should also be given. The early stages of "B_2" deficiency may be manifested by *1.* photophobia, lacrimation and injection of corneal margins; *2.* oral lesions with linear fissures, redness and soreness of the corners of the mouth; *3.* seborrheic accumulations in the naso-labial fold and around the eyelids or ears. Therapeutic response to 5 mg. daily for one to two weeks with rapid clearing of symptoms, would constitute reasonable evidence of "B_2" deficiency. The B-Complex in some form should also be given. The most readily appreciable evidences of a "C" deficiency are small hemorrhages into subcutaneous, subperiosteal, gingival and other tissues. Delay in healing of wounds, sponginess and slight swelling of the gums may be observed. Laboratory tests include: *1.* analysis of "C" content of blood and urine; *2.* measuring excretion following test doses; *3.* X-ray of bones revealing characteristic changes; and perhaps *4.* capillary fragility and resistance tests. Orange juice in large amounts of "C" in doses of 200-1000 mg. daily should produce a rapid disappearance of symptoms.

Carlson's[18] intimate experience with food problems in Europe at the close of World War I augments the authority with which he comments extensively on the food problems of the world today. Grains fed to animals to be converted into meat, milk or eggs actually return less than 20 per cent of the original food values. A dietary nearly or wholly devoid of expensive milk, milk products and meat and consisting

only of grains, legumes, fruits and vegetables suffices to promote growth in the young and to sustain health and vigor in the adult. In Europe and Russia whole rye and whole wheat have been staples for centuries — possibly for thousands of years. The Russian soldier has stood up well and fought well on these dietary staples. It is erroneous to regard these as inadequate for Americans. The very same authorities responsible for impeding the use of modern oleomargarine (which is equal in value to butter) announced two years ago that one-third of the American people were poorly fed; and that only 23 per cent were on diets capable of maintaining good health. In questioning this it is pointed out that medical examination of draftees did not indicate such a tragic state of diet and health in our nation. Today the draftees are a little taller than those of World War I, and both are taller than our soldiers in the Civil War. Today's draftees are also heavier than those of 25 years ago. Stefansson found that dental caries and frank vitamin deficiency diseases were unknown among Eskimos until the introduction of our processed foods. Despite such knowledge throughout all these years, foods are still being processed into inferior products. When wheat bran from the flour mills is fed to hogs, chickens and cattle, these receive the better parts of the grain. It is misleading to add two or three vitamins and some iron and lime to denatured flour — and then call it "enriched." As a matter of fact it is still impoverished. We are not so intelligent as the animals; when food is abundant the gray squirrel and the rat eat only the germ of the grain and leave the rest. We eat the rest and feed the germ to hogs and cattle.

This sort of thing has been going on for a long time. One hundred years ago Thoreau[19] noted that every New Englander might easily raise all his own breadstuffs. Fresh and sweet meal was rarely sold in the shops and hominy and corn in a still coarser form were hardly used at all. The farmer gave to his cattle and hogs the grain of his own producing — and then bought flour, which was at least no more wholesome — at a store. Thoreau raised his own rye and Indian corn and ground them in a hand-mill.

To convince the public that white flour is vicious seems impossible. When our emaciated prisoners were rescued from concentration camps, they exclaimed "Liberty — and White Bread!" The first is the greatest blessing in the world — but it certainly seems reasonable to say that the second is an actual curse.

Wasteful practices should have no place in a wartime — or post-wartime — food economy. Lorenz[20] estimates that about 15 per cent of American food is wasted. Taste and waste are two of the greatest difficulties encountered; however, as belts are tightened wilful waste decreases. Leftover butter-pats are harder to find in restaurants today. (Oleomargarine has made its appearance on many tables which were strangers to it before. The Council on Foods and Nutrition[21] has given assurance that when margarine is fortified with "A" — 9000 units per pound — it can be used in place of butter with no nutritional disadvantage.) To extract the maximal value from the wealth of information that is available today, we need group discussion, with decision, under trained leaders.

"Back to the Soil" is, in effect, the tenor of Wrench's[22] study of food and living habits in different peoples. He had lived many years in India, and made it his prime objective to ascertain why this or that disease or type of malnutrition is characteristic of a given area or population. The highest level of health attained and maintained by any one portion of India's millions is that of the people inhabiting the native state of Hunza near the border of Afghanistan. The blight of civilization's refined and impoverished foods is not their blight. Their lot is good air, industry in cultivation, conservation of all natural food elements, hardy physique, practically no illness. He contrasts the pitiful state of the peoples of Madras and Bengal and Travancore with the buoyant good health of the mountain folk. Much of Wrench's material is from other investigators, whose work was in some cases the application to laboratory rats of food schedules of native populations; on this he builds up an eloquent argument for appraising inadequate nutrition as an outstanding causative

factor (if not the immediate cause) of many illnesses, such as pneumonia, peptic ulcer, tuberculosis. Over-cultivation with consequent mineral impoverishment of the soil, purposeful destruction of food waste and excreta (on behalf of public health), immeasurable waste of food elements in civilization's mills and kitchens — all are held to blame for civilized man being the victim of civilization's diseases.

It seems to Pett[23] that there are many abuses and very few indications for prescribing vitamins. We should rely on sound dietary habits and the intake of a varied diet of natural foods. Exceptions to this include *1.* a low intake of food vitamins due to poverty, fads, ignorance, lack of interest, psychopathia or old age; *2.* absorption impaired by emesis, diarrhoea, cholecystic disease and obstruction; *3.* stresses like pregnancy, operations, hyperpyrexia and interfering action of drugs such as the sulfonamides; *4.* interference with storage or excretion of vitamins, as in excessive excretion said to be caused by salicylates.

The body cells are apparently capable of building up enzymes; but Aron[24] explains that the body is completely dependent upon outside sources for the "co-enzymes" — which make the enzymes work. Essential components of these co-enzymes are vitamins which the human body cannot synthesize. Historically, the first of these were "B_2" and niacin. One of the most interesting of this group is "B_1." All Carbohydrates are finally broken down into CO_2 and H_2O. The last step of this process requires an enzyme — "carboxylase" and a co-enzyme, "co-carboxylase." When this co-carboxylase was isolated it was identified as a derivative of "B_1." One relationship of "B_1" to carbohydrate metabolism is of striking interest: It has been shown that the central nervous system depends entirely upon carbohydrates as a source of energy. Sugar necessarily draws on the "B_1" stores of the body and it seems wise, when glucose is given intravenously, to fortify it with not less than 1 mg. of "B_1" for every 50 gms. of glucose. In their distribution in the body there is a sharp difference between the water-soluble and the oil-soluble vitamins. There is about ten times as

much "B_1" circulating in the blood as is stored in the liver; but there is three times as much "C" stored in the liver as is circulating in the blood. The amount of oil-soluble "A" stored in the liver is one hundred times that in the circulating blood. The lesson from this for clinicians is that "B_1" should be taken continuously. "C" may be taken more intermittently; but "A" can be taken at any time. Even if no "A" whatever were in the diet, "A" reserves in the liver of a well nourished person would be sufficient to sustain the "A" level in the blood for nearly a full year. This is another refutation of the claims of those[25,26] who "cure" defective color vision promptly by the administration of "A."

When we first attempted to apply the knowledge of vitamins to clinical practice, one of our associate editors said, "That's fine — now do the same thing for the hormones." That was a large order! Fortunately Harris and Thimann[27] have provided practical information in their books "Vitamins and Hormones" — which include critical surveys by many authors. To McCallum[28] it is astonishing that the chemistry and physiology of vitamins and hormones have progressed so far in so short a time. Evidence of the existence of what we now call "vitamins" was first shown by N. Lunin, a pupil of von Bunge in Basel in 1881. He observed the rapid decline of animals on limited diets and was then able to improve their condition by adding a small amount of whole milk. He correctly interpreted his observation to mean that there existed some essential nutrients which had been hitherto unsuspected. It was not until after the epochal studies of Hopkins and of Funk were published that vitamin research was launched upon its amazing journey. In the case of the hormones there has never been any question that the demonstration by Bayliss and Starling, in 1902, of the existence of the chemical regulator, secretin, clearly places them as the fathers of the hormones. The vitamins enable the raw materials to undergo the changes which come under the term "Metabolism." To their peculiar properties are due many fundamental processes of life. The balance and integration among the bewilderingly complex processes of different tis-

sues are, in great measure, controlled by the hormones. Physically, mentally, sexually and emotionally we are largely the products of our hormones.

To study the prenatal vitamin needs of a child, Robertson[29] selected two hundred expectant mothers who had been on very poor diet. These were divided into two groups; to one group extra food was given; the other group received only a placebo. The supplemented-diet mothers had far fewer complications during pregnancy, labor and post partum than the poor diet group; and 50 per cent more of their infants were in good condition during their first two weeks of life. In order to guard against hemorrhagic disease of the newborn it is advisable to give 5 mg. of "K" in oil by mouth to all mothers 4 to 40 hours before delivery. It is recommended that the lactating mother should receive an abundance of essential foods. It seems wise that the infant receive "C" (best given as orange juice) and "D" (preferably as fish-liver oil) beginning at 2-4 weeks of age. During the first year the amount of orange juice should be increased until at 10 months the child is receiving 3-4 ounces.

The studies of Burke, Beal, Kirkwood and Stuart[30] bring out the significant relationship between the diet of the mother during pregnancy and the condition of the infant at birth. They emphasize that growth requires more dietary essentials than mere maintenance; and growth begins with conception — not with birth. From the fourth through the ninth month the pregnant woman requires considerably more calories, protein, calcium, phosphorous, iron, "A," "B_1," "B_2," niacin, "C" and very much more "D." Over a period of fifteen years a careful statistical study was made of two hundred and sixteen mothers and their infants — with the following conclusions: Poor diet during pregnancy means a poor infant; an excellent diet means a healthy infant. A good diet during pregnancy promises freedom from pre-eclampsia, whereas with a poor diet the mother runs an almost 50 per cent chance of pre-eclampsia.

As to the "A" deficiencies, Perlman[31] emphasizes that their classic signs in man are practically unknown in this country.

This is explained by its adequate intake by most of our population, and also by the plentiful storage of "A" that remains in the liver through very long periods of depletion. Even in animals, it is only the young that show changes. Further, these animals even on extreme depletion have to be carried for a long period relative to their life span before signs of depletion develop.

In discussing his experimental work Mellanby[32] commented that, seventeen years before, he had noted that otitis media could be produced with some regularity in rats by omitting "A" from the diet; and that he then felt that otitis media in children also might be related to an "A" deficiency. He now considers that this is not the case. It was just unfortunate that the rat was chosen for this experimental work, since it reacts to an "A" deficiency in a particular way. The rat develops epithelial hyperplasia, especially in the Eustachian tube — and this is generally followed by infection to the middle ear.

A forty year old woman of an Arab village was sent to Gill[33] for treatment of tinea capitis, a disease common in Palestine. He found an area of alopecia with no microscopic evidence of mycelia or spores. Skin of the face was dry. The nose, adjacent parts of the cheek, chin and upper lip were scaly and rough, partly depigmented and partly of dirty slate color. Hyperkeratosis was noted on many parts of the body. Her diet had been chiefly rice, legumes, mutton fat, bread and black coffee; she seldom ate vegetables and fruits and had a meat dish only about once a month. Treatment consisted of milk, eggs, carrot juice, green vegetables, liver, butter and large amounts of "A." In two weeks her condition was markedly improved with diminution of the skin lesions and a beginning good growth of hair on the bald area.

There is no nutritional need that seems to Keys[34] more important than the human requirement for vitamins of the B-Complex. Yet it is necessary to emphasize that statements as to the exact amounts needed by man are as yet based on very tenuous evidence. If the individual's previous diet hap-

pens to have been unusually rich in the B-Complex, then he would withstand privation for a longer period. The only acceptable evidence on the exact requirements for the B-Complex is that derived from controlled experiments on man — and the amount of such evidence is still pitifully small.

A note of encouragement is sounded by Ruskin[35] for surgeon and patient in cases where, after the simple or the radical mastoid operation, healing is delayed or the post-operative course is unsatisfactory. Much attention has been given in the past eight or nine years to the need of "C" in disease and in the healing of wounds. Ruskin strongly advocates the use of a sulfonamide — "C" compound, for example either sulfanilamide ascorbate or sufathiazole ascorbate, a conjugated form in which the sulfonamide is combined equimolecularly with ascorbic acid. In powder form he used this compound in seven cases of continued suppuration after mastoid surgery and in eight cases of chronic otorrhea. After irrigating, cleansing and drying he applied the remedy either by "packing," *i.e.*, filling the entire cavity with the powder, or by "frosting," *ie.*, blowing the powder into the cavity. Epithelization progressed, granulations disappeared, discharge lessened or ceased. He cites an earlier contribution which he[36] made to the problem of myringitis bullosa hemorrhagica, commonly called grip otitis. There occurs in grippal infections a rapid depletion of the plasma ascorbic acid, and the involvement of the tympanic membrane is actually a manifestation of acute scurvy. The administration of "C" in large doses, sometimes with sulfanilamide, brought about rapid resolution.

To investigate the common cold, Brown and his associates[37] made a careful study of a large number of college students. They were divided into a group that received "C" (1 gm. daily for two days), and a second group that received a placebo — citric acid. The conclusion was that massive doses of "C" were helpful in shortening the duration of the common cold — provided it was administered immediately after onset.

With an introductory review of work done on cattle and rats, Bonnin[38] reports the value of "C" in augmenting the effects of estrogens in menopausal women. When Stilbestrol alone failed to relieve hot flashes, headaches, vertigo and hypertension the addition of "C" gave excellent results. This combined therapy consisted of Stilbestrol 0.5 mg. and "C" 75 mg. The favorable course, including marked lowering of blood pressure, lasted only as long as the combined therapy. It appeared that Stilbestrol lowers the blood level of "C"; and therefore, that this vitamin in generous amounts should be administered in combination with the hormone.

Introducing his own findings with a review of conflicting opinions held by earlier investigators, Newbold[39] reports the results of administering "C" to 8 young men subject to hay fever. Their common allergen was short ragweed. He is unable to note any benefit from the use of "C." Similarly, after careful checking of the pollen curve in the hay fever season of last fall, Friedlander and Feinberg[40] on the basis of tests in 43 patients to whom "C" was administered, conclude that even very large doses fail to affect the course of hay fever or asthma.

In addition to arsphenamine, intravenous or local, and a high oral concentration of the sulfonamides, Jones[41] recommends "C" in treating Vincent's Angina.

Cody[42] considers that recent investigations confirm the general principle of vitamin therapy — that a vitamin can relieve only those symptoms caused by its deficiency. The avitaminotic diseases are clinical entities — with a definite pattern of symptoms and pathologic change, whether in man or in laboratory animals. Manifest avitaminotic diseases are rarely if ever encountered by the otolaryngologist; only the latent cases are seen. The benefiting of frequent colds by "A" suggests a deficiency of "A" — initial symptoms usually nasal, later ocular; history of "persistent sniffles"; diet deficient in milk, butter, carrots, spinach and tomatoes; bilateral mucoid discharge, becoming thicker and more profuse. Such a picture suggests the therapeutic test of cod liver oil. Definite improvement within two or three weeks would seem to con-

firm the deficiency. Similarly, such a test may show lack of "A" responsible for certain types of chronic sinusitis wherein one finds only slightly hyperemic nasal mucosa, thick mucopurulent bilateral discharge, no sneezing, and antra clear on transillumination. Atrophic rhinitis probably has several etiologic factors, of which avitaminosis is only one. Differential diagnosis between atrophic rhinitis due to avitaminosis and that due to other causes is uncertain and unsatisfactory, since the therapeutic test extends over the prolonged period at present necessary for the reversing process. "A" has been of no benefit in allergic conditions. Pellagra, ariboflavinosis and latent beriberi have a higher incidence and wider distribution in this country than other avitaminotic diseases. The usual diet of Americans, particularly in the South, is closer to the level of clinical deficiency for the B-Complex group than for any other vitamin. The otolaryngologist usually encounters cheilosis and fissures at the angles of the lips, due to "B_2" deficiency, when they are found incidentally to examination for other diseases. Cody describes a nasal syndrome due to "B_1" deficiency; slight, frequent postnasal discharge; occasional sneezing; no headache; young women most often affected. Nasal mucosa appears normal except over the middle turbinate. Posterior tips of the middle turbinate have smooth, moist, creamy white, thickened, slightly edematous appearance. No mucopus is found; leukocyte and differential counts are normal. The edema is readily differentiated from allergy. Under therapeutic test of 30 mg. of "B_1" daily discharge lessened in three days and ceased in fourteen. The clinical appearance of the enlarged arytenoids in "B_1" deficiency and in tuberculosis is somewhat similar. In "B_1" deficiency the swelling of the arytenoid is similar to that in tuberculosis, but not so large and of firmer texture. The optimal requirement of "B_1" is increased in chronic tuberculosis. It may be that "B_1" deficiency is an etiologic factor in tuberculous arytenoid hypertrophy. Such hypertrophy has been observed to decrease in size within seven days on administering 30 mg. of "B_1" daily — but conditions did not return to normal. Patients with globus hystericus who have arytenoid edema typical of a "B_1" deficiency are relieved of symptoms

within five days by 30 mg. of "B_1" daily. It is hard to decide in hysterical patients whether improvement is due to suggestive therapy or to the "B_1." Of course, not all cases of globus hystericus are due to "B_1" deficiency, but some of them are. As to the value of "B_1" in tinnitus and impaired hearing, the evidence now suggests that improvement could be expected only in latent beriberi. Cody gives 200 mg. of "C" daily to many patients with hay fever symptoms — with no benefit to some, with improvement or cure in others. The symptoms of the group showing no benefit were diagnosed as nasal allergy; but the improvement or cure in the other group indicated that vasomotor rhinitis may be an early symptom of latent or subclinical scurvy. Nearly all of the latter group were on diets containing little or no citrus fruits or fresh vegetables. "D" plays a part in metabolism of calcium and phosphorus and in the maintenance of their normal ratio to each other. It may raise the level of serum calcium, correct the hypocalcemia of tetany and parathyroid insufficiency and so be effective in the treatment of tetany due to low blood calcium. Laryngismus stridulus is a symptom of tetany. The otolaryngologist, in prescribing vitamins, should treat diseases — not symptoms.

The protean nature of the symptoms of allergy and the equally varied results of avitaminoses result in an overlapping, and in difficulty in determining in which category a given case belongs. This is exemplified in the group of cases which includes sufferers from certain cephalalgias, Meniere's syndrome and allergies whose specificities are obscure. The pioneer investigators of anaphylaxis and its mechanisms in 1908 assumed the formation of a toxic chemical substance; in 1910 responsibility for the phenomena was laid to histamine. Its role in anaphylaxis and allergy is carefully studied by Code;[43] this substance, which we might call the rogue of metabolism, is found in varying proportions in the white blood cells and the skin. Its proper function is to effect *1.* contraction of smooth muscle, *2.* dilatation of capillaries, *3.* stimulation of excretory glands. Injected into rabbits it causes a pulmonary vascular constriction; injected into dogs, a fall in blood pressure and a reduction of the coagulability of the blood. The former effect

is caused by the histamine itself, the latter by the release of heparin from damaged liver cells. Code draws the distinction between histamine-bearing and non-histamine-bearing cells. The former liberate histamine into the circulation; the latter suffer damage from its release, even to a degree severe enough to cause death. A sensitizing agent may enter the body by one of three routes, *1.* skin and conjunctiva, *2.* upper or lower respiratory tract, *3.* gastro-intestinal tract. By its invasion through one of these barriers and its entrance into the circulation, the histamine-containing tissues are impelled to release their histamine and the circulation becomes flooded with this highly active capillary dilatant. In a sensitized individual the effect upon blood-vessels and glands may pass far beyond physiologic limits. On the basis of liberation of histamine can be explained acute reactions of various tissues, skin or bronchioles or glands, which confront the clinician in the formidable array of allergies.

A classification of Meniere's syndrome due to vascular change has been suggested by Atkinson.[44] One of two vascular mechanisms is at fault, either the vasodilator or the vasoconstrictor. Either can produce the characteristic picture. These two groups can be differentiated by intradermal test with histamine. Treatment appropriate to one group is inappropriate — in fact deleterious — in the other. In the vasodilator group satisfactory results have been reported[45,46,47] by desensitization to histamine. In the much larger, vasoconstrictor group, the response to histamine injected intradermally is normal. In a series of 110 cases, all of the vasoconstrictor type, nicotinic acid was given. All had been tested by intradermal injection of histamine and had given a normal response. Two principles are observed in the treatment: Produce a vasodilator effect; and maintain that effect continuously until such time as control is obtained — which may be many months. Nicotinic acid can be given over long periods without harm. Moreover, its action is at the periphery of the vascular system on the smallest vessels — as is apparent from the cutaneous flush it produces. This is just the effect desired because it is the circulation in the capillaries of the stria vascularis which is believed to be at fault in this condition. Naturally nicotinic acid should

be used and not nicotinamide. These two substances are interchangeable in their vitamin effect, but nicotinamide has no vasodilator action. Atkinson has seen many patients who have been treated with the amide without result, who were then treated successfully with the acid. In one instance the patient went to the druggist for more nicotinic acid only to be told: "Why not use the improved flushless preparation?" The patient agreed to this suggestion and promptly began to have recurrences of his symptoms. When he was put back on nicotinic acid, the symptoms were again relieved. Only with adequate dosage, long continued, can success be expected. Nicotinic acid must be worked up to the highest dose which the patient can tolerate. This must be determined for each patient as there are wide individual variations. Dosage must be kept at this top level until the symptoms have been relieved and then gradually reduced to the minimum necessary to maintain control. This maintenance dose must be continued for months — perhaps even for years. It seldom occurs that complete relief is obtained at once, and this should be thoroughly explained to the patient. Only when the cause has been discovered can appropriate treatment be instituted for Meniere's Syndrome. Whether salt-free diet, ammonium chloride, histamine, nicotinic acid or operation—there is no one or final answer to the harassed victim's prayer. There is no one "correct" treatment for all cases of Meniere's Syndrome. The method of nicotinic acid treatment found most efficacious is to start with injection and then gradually wean the patient from injections to oral administration only. Patients who have shown no response to oral therapy often respond promptly to injections. Major attacks become minor; minor attacks become less frequent — and cease. Tinnitus and head pains subside or disappear. When it is necessary to gain control quickly intravenous therapy is indicated. When time allows it is wise to start with intramuscular dose of 30 mg. With that as a guide, 25-35 mg. may be given as the first intravenous dose. Treatment is repeated daily or every second day until 6-8 doses have been given, increasing the dose by 5 mg. on each occasion until a maximum is reached — usually about 50 mg. After a few days, oral

administration is started in addition — usually 50 mg. is given twice daily on the days of injection and thrice daily on other days. Following the course of intravenous injections a course of intramuscular injections is started. These are taken daily for 1-3 months, then gradually diminished in number. During the course of intramuscular injections, 100 mg. or more may be taken by mouth on the days of injection, 150 mg. or more on the other days. After several months, oral treatment alone may be substituted provided the symptoms are under control. In 84 per cent of 110 cases treated with nicotinic acid. the attacks of vertigo were relieved or greatly modified.

Shea's conception of the manner in which histamine acts in allergy leads him[48] to present the results of his experience in the particular field of histamine cephalalgia, Meniere's syndrome and sundry allergic conditions. He gives due credit to Horton and his fellow-workers at Rochester. He adopts Horton's method of administering histamine — not his original intravenous method, but graded hypodermic dosages through a period of up to 10 days or in some cases longer. Shea takes issue with the teaching that by skin tests alone one can determine whether to resort to histamine or to nicotinic acid. Although he has more than three hundred patients' records on which to base conclusions, he professes his inability to tabulate results in statistical form. He uses nicotinic acid hypodermically, the patient lying down; the injection may be on alternate days, spaced by oral doses of 50 to 100 mg.; in his view the amide (niacinamide) is of no value in the treatment of vertigo inasmuch as it does not produce the same vaso-dilatation. The records of eight of Shea's patients are given in sufficient detail to illustrate the clinical effect of each of the two therapies.

As to vitamins found in ocular tissues, with whose function they are concerned, Hahn[49] gives a summary. "A" — cornea — maintenance of intact epithelium, necessary for the normal respiration of the cornea; retina — essential for the regeneration of visual purple when bleached by light — thus permitting vision in dim light. "B_1" — nerve tissue — metab-

olism of nerve cells, hence the reception and conduction of visual stimulus. "B_2" — cornea — essential to respiratory mechanism of the corneal stroma. Retina — mechanism of light perception and conversion to visual stimulus. "C" — essential to the secretion of intraocular fluids by the ciliary body; essential to metabolism and respiration of the crystalline lens. "E" — concerned with reparative processes. "K" — essential to the process of blood coagulation. "P" — concerned with the maintenance of the walls of blood vessels.

The role of vitamins in the physiology of vision is discussed by Hahn.[50] A nutritional inadequacy begins the instant that adequate amounts of any essential nutrient fail to reach the cell. The successive stages of malnutrition are tissue depletion, biochemical lesions, altered function and finally anatomic lesions. As a rule we detect these stages in reverse order — anatomic lesions, altered functions, biochemical lesions and tissue depletion. The first significant act in a series of events which we call vision is absorption of light by the rhodopsin — particularly light from the middle of the spectrum and of low intensity. The chemical change results in nerve impulses which the brain interprets as vision. When rhodopsin is bleached by light it breaks down into retinene and a protein. The yellow color of retinene fades and "A" is produced. While the rhodopsin remains bleached, vision is impaired — especially in a dim light. In the dark rhodopsin is resynthesized. The retina must receive a constant supply of fresh "A" from the blood to supplement that received from the retinene because some of the "A" is destroyed.

Out of 305 cases of chronic urticaria, including angioneurotic edema, observed by Black,[51] almost one-half obtained relief after due attention to diet, infections or allergies. Of the remaining 156, prothrombin-time determinations were made in 119. Synthetic "K" was administered orally to the entire 156 in doses of 2 mg. before each meal, for periods of from one to four weeks. Of this group 90 were relieved; but of these, relapses occurred in 28 — whereupon "K" was readministered with prompt relief in each instance and without further relapse. In 56 cases of asthma, nasal allergy and eczema, "K" therapy gave no relief.

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AN IMPROVED METHOD FOR CLASSIFYING AUDIOGRAMS.

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I. INTRODUCTION.

Whenever large numbers of pure tone audiograms are to be grouped for study and analysis, it is essential that they be classified in some simple and definite manner. Various systems have been suggested for coding audiograms to serve this purpose. The best of these systems is probably the one devised by Guild.[1] Even Guild's method, however, at times lacks precision and flexibility. There is need for a coding procedure which is both clean-cut and elastic. Each audiometric curve must be classified in a distinctive manner, yet after classification the method as a whole must allow audiograms to be sorted into such groupings as best serve a particular investigation.

A method of classifying audiograms was devised to meet the need of the Acoustic Clinic at Deshon General Hospital. The aim was to achieve a coding procedure which would be inclusive in its scope and universal in its application.

A. Features of the Deshon Classification System.

The Deshon classification system incorporates the following characteristics:

1. The system defines a small number of basic curve types, or major categories, so selected that they encompass most audiometric patterns encountered in everyday testing.

2. The system represents severity of loss in a manner which is independent of basic category.

3. The system utilizes a simple method for indicating deviations from the basic category. This method indicates: *a.* type of deviation; *b.* position of deviation; *c.* magnitude of deviation.

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4. Unusual audiograms can be classified without complicating excessively the number of categories.

5. There are definite rules governing decisions in classification. These rules were chosen to allow precise categorizing of borderline audiograms.[2] For the system to function properly the rules must be followed rigorously.

6. The method of notation, of symbolizing the classification, allows quick sorting of audiograms either into broad groups or into finer subdivisions as needs indicate.

7. The system is reversible. It allows an audiogram curve to be redrawn approximately from its code notation.

B. Steps in Coding an Audiogram.

In broad outline, the following steps are involved in coding audiometric curves according to the Deshon system:

First, the curve is assigned to the appropriate basic category. The category is indicated by a key letter. This is written as a capital. The key letter is the "core" of the notation to be made for the audiogram.

Second, the severity of loss is represented by affixing a subscript to the previously mentioned symbol for the major category. The number used for this subscript is the loss in decibels at 1,024 c.p.s. Once this point has been established, the approximate loss at the other test frequencies is implied by the form of the curve.

Third, any marked deviation from the pattern of the basic curve is represented by an appropriate modifier placed adjacent to the symbol for the major category. This modifier is written as a small letter. It precedes the major category symbol if the deviation is in the low frequency portion of the audiogram. It follows the major symbol if the deviation is a high frequency one.

Fourth, the location on the audiogram of each deviation is shown by a subscript attached to the modifier symbol. The subscript selected is the one which designates the octave at which the deviation unites with the basic pattern of the curve.

Finally, in those instances where it is necessary, the extent of a deviation is recorded by a superscript attached to the symbol representing the deviation.

When it is impossible to assign a major category, the audiogram is coded in the manner described above, except that the major category symbol is replaced by a small letter representing the central portion of the curve.

In summary, then, the "core" in the Deshon coding system is a single capital letter which represents the primary pattern of the audiogram. This "core" is surrounded by a small group of supplementary letters and numbers. These indicate the severity of loss, the types of deviations from the main pattern, the locations of these deviations and their extent. A visual representation will clarify the relations in the Deshon code notations. The various symbols are placed spacially as shown in Fig. 1.

With the foregoing in mind, one is ready to consider the details of the classification system.

II. MAJOR CATEGORIES.

Five major categories, or basic curve types, are included in the Deshon system for classifying audiograms.

These categories were chosen on the basis of clinical experience and the analysis of audiogram types made by Guild.[3] Each is distinctive, yet as a group they embrace the variety of major trends observed in clinical audiometry. The five categories are illustrated graphically in Fig. 9 and include the following types:

1. Flat: approximately equal loss for all frequencies.

2. Gradual downward slope: progressively greater loss for higher frequencies at a slope of 5 to 10 db. per octave.

3. Marked downward slope: progressively greater loss for higher frequencies at a slope of 15 to 20 db. per octave.

4. Rising: progressively less loss for higher frequencies, the rise being 5 to 10 db. per octave.

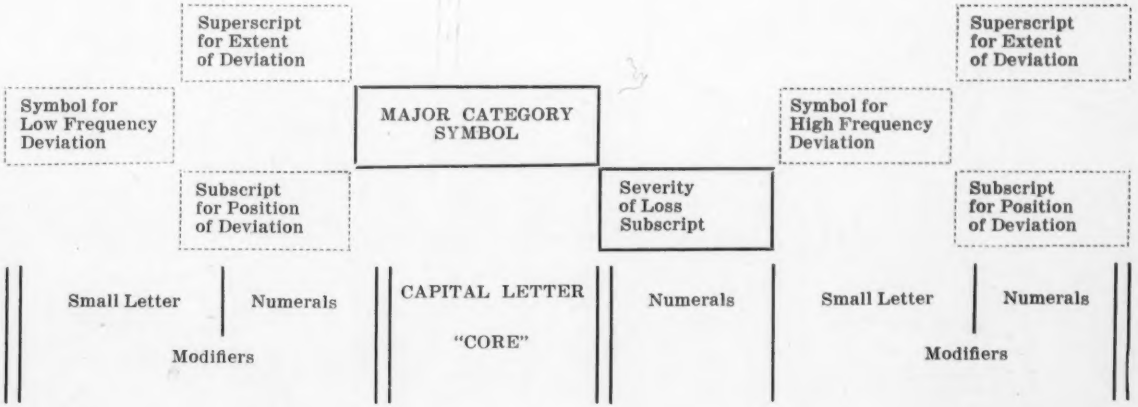

Fig. 1. Diagram of spacial relations in making code notations for classifying audiograms according to the Deshon system.

5. Trough: greater loss in the middle frequency region, with at least 20 db. more loss at the middle of the audiometric curve than at its extremes.

When coding an audiogram the major categories are represented by the following key:

F = Flat
G = Gradual downward slope
M = Marked downward slope
R = Rising
T = Trough

One seldom sees actual audiograms which conform perfectly to the foregoing types; therefore, it is important to define the limits of deviation within which audiograms will still be classified as being of a particular type. The rule established to cover this point is that *the deviations shall fall within ± 10 db. of the "curve of best fit."* In other words, an audiometric curve meets the requirements of a category if all its points are within 10 db. of the idealized curve for that category, providing the idealized curve is so placed that the total arithmetic deviation between the actual curve and the ideal is the least obtainable in that particular case.[4]

On rare occasions a *single* deviation of 15 db. is allowable if in other respects the requirements of the major category are maintained and if there is no more precise way of coding the audiogram.

There are times when an audiometric curve can with equal legitimacy be put in either of two basic categories. Under these conditions one arbitrarily classifies the audiogram in the category which is closest to the Flat type. Thus, **F** would be chosen over **G**, **G** over **M**, and **F** over **R**.

On many occasions only part of an audiogram fits into a major category. The major category notation continues to be used providing at least four consecutive octave points (a range of three octaves) conform. The deviation of the remaining points from the major category is indicated in the manner described in Section IV.

Once the correct major category is determined, the appropriate key letter is written down. This letter serves as the "core" around which the necessary modifiers are subsequently written.

III. SEVERITY OF LOSS.

After the notation for the major category has been made, the severity of the loss is indicated by recording where the "curve of best fit" intersects the axis for 1,024 c.p.s. This point is often, but not necessarily, the threshold obtained at 1,024 c.p.s.

In coding an audiogram the point of intersection is recorded as a subscript to the symbol for the major category. This subscript is the decibel difference between zero (normal threshold) and the point of intersection of the 1,024 cycle

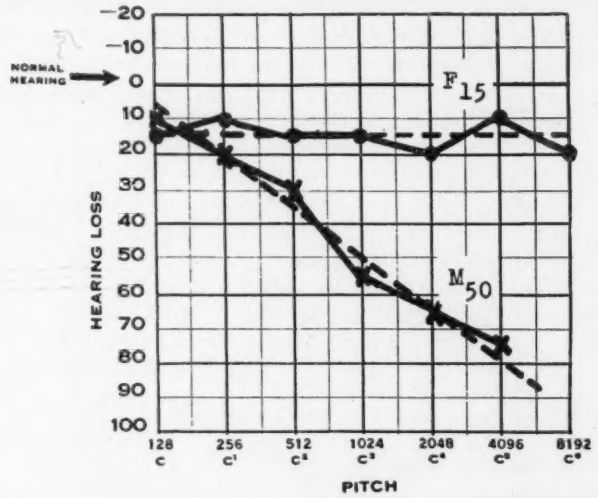

Fig. 2. Audiometric curves illustrating application of the basic categories in the Deshon classification system. Dotted lines represent "curve of best fit."

axis. Thus, as shown in Fig. 2, $\mathbf{M}_{50}$ represents an audiogram with a marked downward slope. The idealized **M** curve which "best fits" this audiogram crosses 1,024 c.p.s. at the 50 db. loss level. Likewise, $\mathbf{F}_{15}$ symbolizes a flat audiogram whose "curve of best fit" crosses 1,024 c.p.s. at the 15 db. level.

There are instances when no major category can be assigned to an audiogram. When this occurs, the subscript for severity of loss is attached to the modifier which applies to the central portion of the audiogram. This will be explained more fully as the various modifiers are described.

IV. MODIFYING CHARACTERISTICS.

Many an audiogram is sufficiently irregular so that it cannot be coded adequately unless its deviation from a major category is indicated. Other audiograms do not fit any major category. Both types can be effectively summarized by the use of modifier symbols. With certain of these symbols it is necessary also to include supplementary notations designating the location of the deviation and its magnitude.

The modifiers employed in the Deshon system are of three kinds. The first type indicates excessive irregularities in an audiogram, although the curve still conforms to a basic category. Two such modifiers, designating jagged and sigmoid characteristics, are employed. They are described in Section A below. The second type denotes sharp deviations from the major categories. It includes peaks, notches and abrupt drops. The positions of these deviations are always described by subscripts giving locations and, when the deviations exceed minimal values, their magnitude is recorded by appropriate subscripts. The procedure in coding such deviations are discussed in Section B below. The third type of modifier is used when a segment of the audiogram conforms to a major category, but when the segment is too short to constitute the general trend of the hearing curve. The application of such modifiers is dealt with in Section C below.

A. General Irregularities.

Some audiograms, which on the whole conform to the basic categories, possess sufficient deviation so that special note must be taken of the extent and type of variability. This is accomplished in the Deshon system by two modifiers, as follows:

j = Notable fluctuation around a basic trend,

s — A sigmoid curve.

1. The **j** modifier indicates generalized fluctuation in the audiometric curve. It is used when the audiogram is too jagged to be considered a good example of a major category and yet when the variations are not sufficient to warrant employing a more specific modifier. The **j** is always a prefix to the major category notation. Illustrative of its application is the coding for the lower audiometric curve in Fig. 3. Here is shown a trough-like curve with a loss of 80 db. at 1,024 c.p.s. The symbolization $\mathbf{T}_{80}$ would be sufficient to describe the curve were it not for the obvious irregularities. The curve deviates sufficiently from the trough characteristics so that special attention must be called to the fact of variability. This is accomplished by affixing a **j** and transforming the notation to $\mathbf{jT}_{80}$. A second illustration of the **j** modifier is given by the upper curve in Fig. 3. Here the pattern is basically flat but it is sufficiently jagged to warrant the notation $\mathbf{jF}_{15}$.

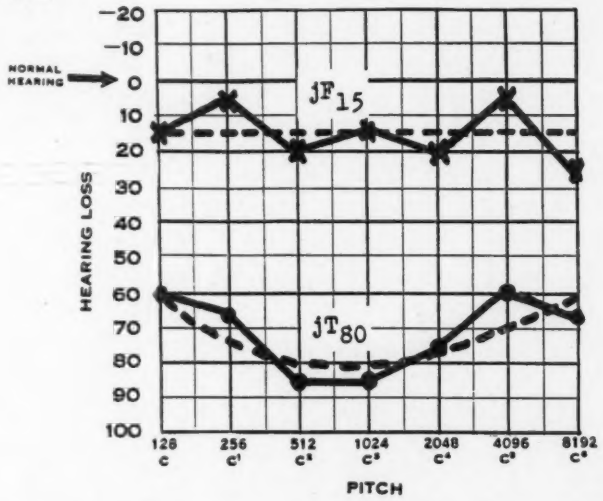

Fig. 3. Audiometric curves illustrating application of irregularity modifier in the Deshon classification system. Dotted lines represent "curve of best fit."

2. The **s** modifier, which indicates a sigmoid pattern, is

used for an audiogram that conforms in general to a basic category but which deviates systematically so that the whole curve is S-shape. A curve is considered sigmoid only when hearing at the low frequency end is better than at the high frequency end.[5] Like the **j** modifier, the **s** symbol is always used as a prefix to the major category notation. Two examples of sigmoid audiograms appear in Fig. 4. One is an $\mathbf{sF}_5$ curve. It is characterized by flat sections at either end with a downward slope in the middle frequency region. The second is described by $\mathbf{sM}_{40}$. This last indicates a marked slope which is somewhat flattened at the two ends. While this curve falls within the limits of a marked slope, it is also serpentine.

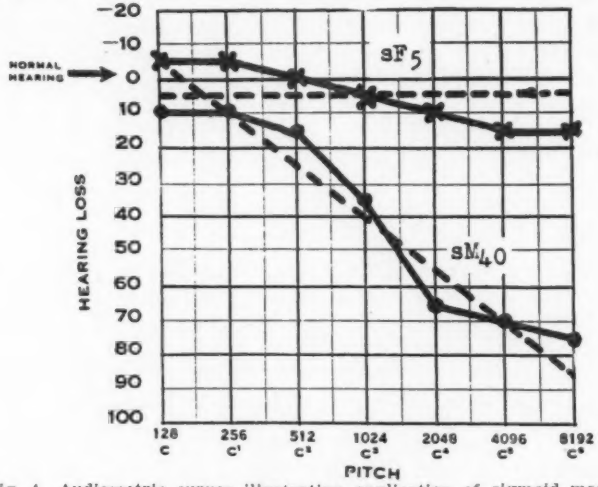

Fig. 4. Audiometric curves illustrating application of sigmoid modifier in the Deshon classification system. Dotted lines represent "curve of best fit."

3. The rules covering the use of the **j** and **s** modifiers are as follows:

a. Use the **j** and **s** modifiers only with major category symbols.

b. Always place these modifiers at the initial position in the code notation.

c. Do not use either the **j** or **s** modifier when other modifiers are employed.

d. Use the **j** and **s** modifiers only when deviations do not reach a magnitude calling for more specific modifiers.

e. Use the **j** modifier whenever the total deviation (arithmetic) from the "curve of best fit" is 25 db. or more. Do not use the **s** modifier unless the total deviation (arithmetic) from the "curve of best fit" is 30 db. or more.

f. When the **j** or **s** modifiers are used, no deviation from the "curve of best fit" should exceed 15 db., but *one* 15 db. deviation is allowable.

g. Do not use a subscript denoting position of a deviation with either the **j** or **s** modifier.

B. Special Deviations.

Sharp deviations from the major categories fall into three main classes: peaks, or humps; notches, or sharp depressions; and abrupt drops. These three classes are designated as follows:

p = A peak rising above the general level of the major category.

n = A notch dropping below the general level of the major category.

a = An abrupt drop of 30 db. or more per octave.

1. Location Subscripts. Special deviations of the aforementioned type may occur at almost any point on an audiometric curve; therefore, their coding must include a method of indicating position. This is accomplished by two conventions.

First, the general location of the deviation is indicated by the place which the modifier occupies in the code notation. When the deviation is in the frequency range below that of the major category, the modifier symbol precedes the "core" symbol. Conversely, the modifier follows the code letter for

the main category when the deviation is at the high frequency end of the scale. In practice the dividing point is the axis for 1,024 c.p.s.

While the foregoing convention indicates general position, it fails to delimit the exact location and horizontal spread of the deviation. To accomplish the latter, the following convention is employed. The frequency axis at which the deviation *joins* the general trend of the audiogram is designated by an appropriate code number. This number is affixed as a subscript to the symbol denoting the deviation. The subscripts used to indicate the conventional octave intervals are as follows:[6]

0 = 128 cycles per second.
1 = 256 cycles per second.
2 = 512 cycles per second.
3 = 1,024 cycles per second.
4 = 2,048 cycles per second.
5 = 4,096 cycles per second.
6 = 8,192 cycles per second.

An illustration will clarify the method of locating deviations in the code notation for an audiometric curve. Consider a perfectly flat loss, at the 10 db. level, out to 2,048 c.p.s., but no responses to test tones beyond 2,048 c.p.s. The "core" of the notation would be $\mathbf{F}_{10}$. Since the abrupt drop is for high frequencies, an **a** indicating this drop would be placed following the $\mathbf{F}_{10}$. Our notation is now $\mathbf{F}_{10}\mathbf{a}$. The point where the abrupt drop starts must still be shown. This point is at 2,048 c.p.s. The location symbol for designating this is **4**. This symbol is placed as a subscript to the **a** modifier. Our notation now becomes $\mathbf{F}_{10}\mathbf{a}_{4}$, which describes the total curve.

2. The Peak Modifier. The **p** modifier represents a peak rising above the general level of the major category curve. The peak may be from one to three octaves wide. If three octaves wide, it must have a minimum rise of at least 20 db. at its highest point. If less than three octaves wide, the rise must be at least 15 db. The crest of the peak may be at any test frequency within the hump. Whenever the rise exceeds the minimal value, its magnitude is indicated by writing as

a superscript the numerical difference in decibels between the "curve of best fit" and the highest point on the peak. Thus, as illustrated in Fig. 5, $\mathbf{F}_{80}\,\mathbf{p}_4^{30}$ codifies a flat loss at the 80 db. level terminating in a peak which joins the flat curve at 2,048 c.p.s. and rises to 30 db. above the general level (that is, to the 50 db. level). The upper curve in Fig. 5 is designated by $\mathbf{p}_2^{20}\,\mathbf{F}_{30}$. As will be seen, the hump is in the low frequency region. The modifier, therefore, precedes the major category symbol, otherwise the interpretation is analagous to the preceding curve.

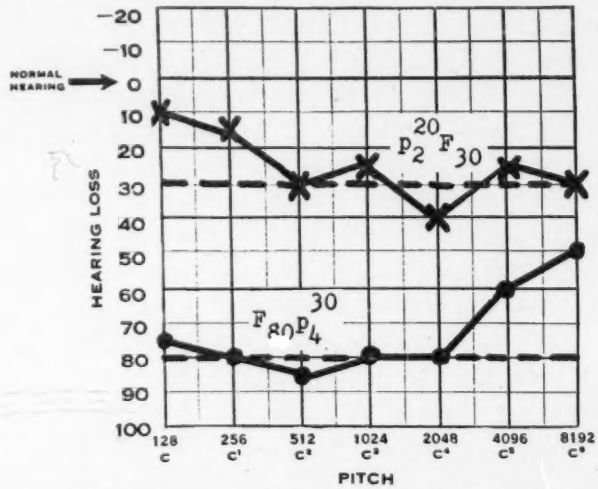

Fig. 5. Audiometric curves illustrating application of the peak modifier in the Deshon classification system. Dotted lines represent "curves of best fit."

The rules for the **p** modifier are:

a. The **p** modifier may be placed in either the initial or final position in the notation. The choice depends upon whether the peak is to the left or right of 1,024 c.p.s.

b. Always use a positional subscript in connection with a **p** modifier to denote the frequency at which the peak and the basic category converge.

c. Use the **p** modifier without a magnitude superscript when the peak is of minimal value (see *Rule f*).

d. Always use the magnitude superscript when the minimal peak value is exceeded.

e. Do not use the **p** notation if the humped section exceeds three octaves. In such cases, the audiogram must be coded in some other manner.

f. A three octave hump must reach a magnitude of 20 db. above the "curve of best fit" before it may be classified as a peak, and a hump less than three octaves wide must have a 15 db. magnitude.

g. Use the **p** modifier to denote a single octave rise of 15 db. or more when the rise is at either extreme of the audiogram.

h. When there is a single peak with a 15 db. rise, it is at times more meaningful to use the **j** or **s** modifier. If this is done, omit the **p** notation.

3. The Notch Modifier. The **n** modifier denotes a depression dropping below the general level of the major category curve. It is the opposite of a peak. The rules for the **n** modifier are identical with those for the **p** modifier — except, of course, that the direction of the deviation is reversed. Hence, these rules need not be listed here; however, two points are worth reiteration. First, the location of the depression is always shown by the two conventions serving this purpose. Second, if the notch is three octaves wide, the depression must deviate (at its lowest point) by at least 20 db. from the "curve of best fit." When less than three octaves wide, the dip must be at least 15 db. Only when notches exceed these minimal values are their magnitudes indicated by superscripts similar to these used for peaks.

At times there may be question as to whether a particular depression in an audiometric curve should be labeled as a notch or an abrupt drop. The basis for choosing between the two is given in the next section.

4. The Abrupt Drop Modifier. The **a** modifier is used to record a sharp break downward in the audiometric curve. Except for a special condition covered by *Rule b* below, it is

defined as having a slope of 30 db. or more per octave. Furthermore, there must be no marked flattening out or rise at the lower end of the drop. When these latter conditions exist, the deviation is coded as a notch.

Typical applications of the **a** modifier are illustrated in Fig. 6. The upper curve, $\mathbf{F}_{10}\mathbf{a}_4$ is a flat curve representing relatively good hearing out to 2,048 c.p.s. Beyond this point, however, there is a marked loss in acuity. Very similar is the second curve. Its code notation is $\mathbf{G}_{50}\mathbf{a}_3$. Here, the general trend is one of loss which increases gradually with frequency. Beyond 1,024 c.p.s., however, no response to test tones is present. The $\mathbf{a}_3$ notation reports this last fact.

The rules for the **a** modifier are as follows:

a. Use the **a** modifier whenever the audiogram shows a downward sweep having a slope of 30 db. or more per octave.

b. The only exception to *Rule a* is when the curve terminates in an abrupt section which goes beyond the limits of the audiometer. Here, providing an extension of the major

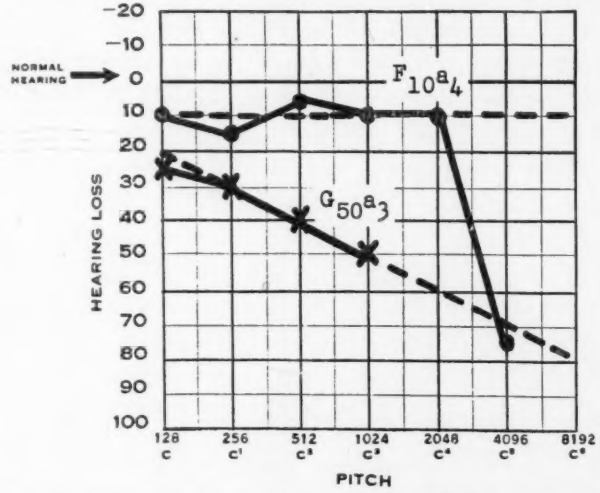

Fig. 6. Audiometric curves illustrating application of the abrupt drop modifier in the Deshon classification system. Dotted lines represent "curves of best fit."

category curve would not go beyond the limits at the same test frequency, use the **a** modifier even if the "curve of best fit" is less than 30 db. from the limit of the audiometer for the frequency at which no response is obtained.

c. If the curve stays within the limits of the audiometer, use the **a** modifier only when the slope does not flatten markedly or rise at its termination. If it does either of the latter, another modifier must be used.

d. The only exception to *Rule c* occurs when the audiogram has an extreme sigmoid shape which cannot be described with the **s** modifier because of the sharpness of its slope in the middle frequency region. Here the **a** symbol is used centrally in the code. It is flanked by appropriate modifiers to describe the extremes of the curve.

e. Use a positional subscript in connection with the **a** modifier to denote the frequency at which the abrupt drop and the basic curve converge.

f. The only exception to *Rule e* occurs when the **a** modifier is used as described in *Rule d*, in which case it carries the subscript for severity of loss. The subscript to be used here is the actual threshold for 1,024 c.p.s.

C. Trend Modifiers.

There are occasions when an audiogram cannot be described best by a major category symbol plus a special deviation modifier. This situation occurs when the curve combines two or three patterns, each of which fits a major category but is too short to be a good description of the total configuration. In such cases, symbols for major categories may be used as trend modifiers to represent short segments. These segments must not exceed three octaves in width.

Whenever the curve is a combination of short segments and of sharp variations which meet the definition for special deviations, modifiers describing the latter are used in conjunction with trend modifiers.

When symbols for major categories are used as modifiers,

they are recorded as small letters rather than capitals.

The use of trend modifiers is exemplified in Fig. 7. The upper curve illustrates a condition where a combination of three trend modifiers best describes the audiometric record. The notation is $\mathbf{f}_2\mathbf{g}_{10}\mathbf{m}_4$. The $\mathbf{f}_2$ describes an initial flat section, terminating at 512 c.p.s. Next comes a gradual downward slope crossing 1,024 c.p.s. at the 10 db. level. This is designated by $\mathbf{g}_{10}$. The final segment of the curve is a marked

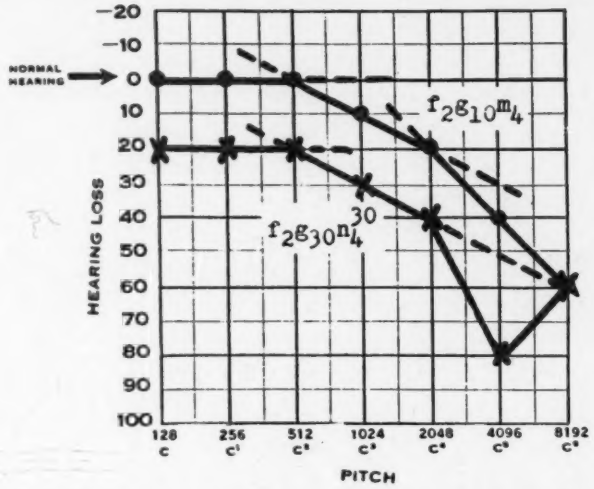

Fig. 7. Audiometric curves illustrating application of trend modifiers in the Deshon system of classification. Dotted lines represent "curves of best fit" for segments of the hearing record.

downward slope which commences at 2,048 c.p.s. and is referred to by $\mathbf{m}_4$. Very similar to the foregoing is the lower curve, $\mathbf{f}_2\,\mathbf{g}_{30}\,\mathbf{n}_4^{30}$. The differences are: *1.* in the severity of loss (the gradual segment crosses at 1,024 c.p.s. at the 30 db. level); and *2.* the audiogram terminates in a notch described by $\mathbf{n}_4^{30}$.

The rules for use of major category symbols as trend modifiers to describe short segments are as follows:

a. Any major category symbol except the trough (**T**) notation may be used to describe a short trend.

b. When used as a trend modifier, the major category symbol is always written as a small letter.

c. When so used, the rules for positional subscript apply in the same manner as for the special deviation modifiers.

d. When so used, the segment must be at least one and not more than three octaves wide.

e. If the segment is three octaves wide, employ the small letter notation only when the contour of the audiogram demands that the coding include three symbols (exclusive of subscripts and superscripts). Otherwise, use the capital letter notation to designate the three octave segment.

f. A trend modifier may be combined with another major category notation which represents a consistent pattern of sufficient length to be symbolized by a capital letter. At other times, an audiogram is best codified by a series of trend modifiers; however, one should employ such a series of trend modifiers only when there is no simpler way of coding the audiometric curve.

D. Fragmentary Curves.

When only a fragment of hearing remains, it is not feasible to attempt coding the audiogram fully. Under such circumstances positional numbers plus a severity subscript are the only notations used. Consider the example of $\mathbf{2}_{85}$**-4,** the curve for which is illustrated in Fig. 8. Here, the positional numbers **2-4** delimit the band within which there is hearing. The subscript **85** represents the average loss within this band.

The rules for coding fragmentary curves are simple:

a. Consider a curve as fragmentary only if it is three octaves or less in width.

b. Do not consider as fragmentary any curve which fits a major category but which cannot be explored through the full frequency range because part of the pattern is beyond the limits of the audiometer.

c. Record the average threshold for the entire fragment

as the severity of loss. This is written as a subscript to the first positional symbol in the notation.

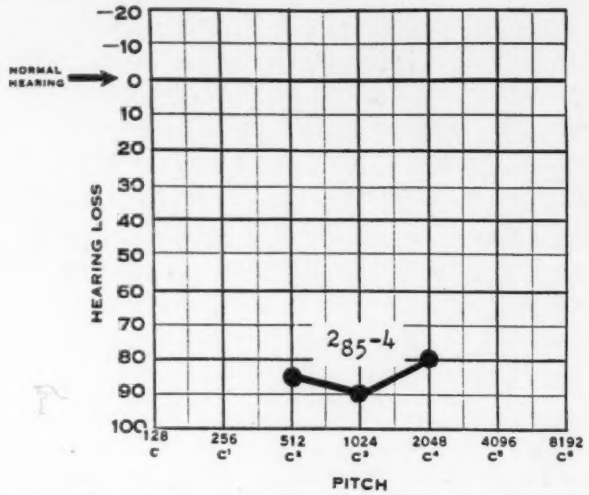

Fig. 8. Audiometric curve illustrating application of the fragmentary notation in the Deshon classification system.

V. APPLICATION OF THE CLASSIFICATION SYSTEM.

In the foregoing sections it has been necessary to cover in detail rules for classifying many kinds of audiograms. As one goes through these rules he is likely to lose sight of the fundamental simplicity of the system. A few basic categories, a few modifiers and a method of indicating the severity of loss can be combined with sufficient flexibility to meet the range of audiometric patterns actually encountered.[7] Furthermore, one must remember that only a small group of symbols is needed to summarize a particular audiometric curve. Ordinarily an audiogram can be represented either by only a "core" symbol with a subscript for severity of loss or by the foregoing plus a single modifier. Only in unusual instances does one find it necessary to divide the codification into three segments.

A primary advantage of the Deshon classification system

is that the coding of audiograms can be completely independent of the future uses to which the data will be put. It is not necessary to know in advance what groupings will be employed. Consequently, audiometric data can be put to uses which are not anticipated at the time the hearing curves are classified.

As an illustration of the foregoing statement, consider the problem of grouping audiograms according to severity of loss. Providing one is conducting a study which calls for only broad differentiation in the amount of loss, it may be desirable to combine all cases whose impairments show severity within a band 25 to 30 db. wide. On the other hand, if the study depends upon fine differentiation of loss, the band may be narrowed to 10 (or even five) db. In either case, the process is merely one of selecting the band limits and then sorting the audiograms according to the subscript for severity of loss.

Similar in principle is the problem of separating audiograms according to the pattern of the hearing curve. Where broad differentiation on the basis of slope is desired, consideration needs be given only to "core" notations; however, superior examples of each basic category can be segregated by taking only those cases for which the code notations contain no modifiers. In a like manner, irregular curves which still conform to basic categories can be isolated by extracting cases with the **j** modifier. Sigmoid curves are also easily identifiable. Furthermore, providing fine differentiations in pattern are desired, selection may be on the basis of both basic category and modifier symbols. Fine divisions may be made in terms of type of deviation, magnitude of deviation and position of the deviation in the frequency scale. For example, flat curves with notches beginning at 2,048 c.p.s. are easily separated from all other types. Even the depth of the notch can be made a basis for differentiation; however, one does not need to employ such fine distinctions unless the purpose at hand warrants doing so.

When the relation of the hearing in the two ears is a prime consideration, appropriate categories may be set up. The better ear curves are first grouped as one desires. Sub-

groups, in terms of pattern in the poorer ear and of discrepancy between the ears, are then isolated to suit current purposes.

One final point should be mentioned: the classification system is reversible to a relatively high degree. That is, given a code notation one can reconstruct the hearing curve with fair accuracy. It is obviously impossible to recreate every observed threshold; however, the curve computed from the code notation will ordinarily be close enough to the original to be within the limits of accuracy usually assumed for clinical audiometry. Once the pattern of the curve and the loss at 1,024 c.p.s. are specified, the approximate positions of all the points on the curve are implied. It follows that a given category will contain highly similar curves. Beyond this, there are times when the code notation is a convenient shorthand method for reporting and transmitting the results of a pure tone test.

VI. SUMMARY.

The Deshon system for classifying audiograms is designed to code each audiogram simply yet definitely. The system is sufficiently flexible so that after audiograms are coded they can be grouped for study purposes in whatever combinations the investigator desires.

A series of steps are employed in coding any audiogram. These are:

A. The basic pattern of the curve is determined and is recorded by the appropriate major category symbol.

B. The severity of loss is computed and is recorded as a subscript to the major category symbol.

C. Deviations from the basic pattern are indicated by modifier symbols appropriately placed before or after the major category symbol.

D. The position and magnitude of each deviation is represented by appropriate subscripts and superscripts attached to the notation symbolizing the deviation.

The Deshon system for classifying audiograms has proven effective and flexible in meeting both clinical and research needs of an acoustic clinic. The system can also prove of value to others whose work calls for the classification and handling of large numbers of audiograms.

APPENDIX. THE CODING TRANSPARENCY.

A transparency which can be placed over the audiometric chart was developed for use with the Deshon classification system. This transparency is illustrated in Fig. 9. With this transparency the code notation which best describes a particular curve can be easily determined and the rules of the system can be quickly applied.

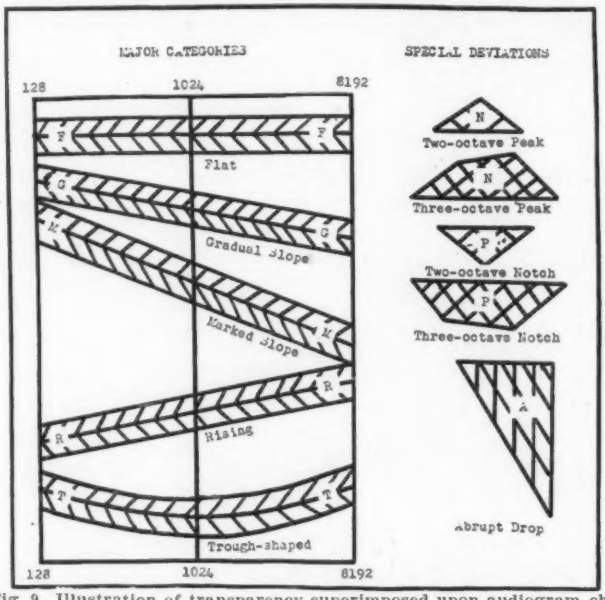

Fig. 9. Illustration of transparency superimposed upon audiogram charts and used as a key to simplify classification of audiometric curves.

The transparency is drawn to the scale of the acoustic clinic's audiogram form. It carries five hatched bands representing the major categories. Each contains an idealized

curve which fits exactly the definition for the major category. This idealized curve is flanked on either side by a hatched area 10 db. wide. In practice, the transparency is squared up over the audiogram so that the major category curve which is most applicable lies in the position where the digressions of the audiogram from the idealized curve are minimal. This is the position, or "curve," of "best fit." The arithmetic total of the digressions is easily computed and decision regarding the use of the **j** or **s** modifier made.

Large deviations from a major category are immediately apparent. In such deviations the audiometric curve departs from the hatched area of the major category. Ordinarily, it is possible immediately to determine the type and extent of the deviation. Whenever there is doubt as to the special category into which a deviation should fall, the transparency is shifted so that the appropriate patterns for special deviations are superimposed on the hearing curve. The lateral tip of each pattern is brought to the point where the deviation and the main curve join. The horizontal edge of the pattern is always laid parallel to the slope of the "curve of best fit" for the main trend. In order for a digression to classify as a special deviation, the audiometric curve must be of the right type and it must fall *outside* the hatched area of the special deviation pattern on the transparency.

When an audiogram combines several trends, each trend can be determined by the same procedure as that used for major categories. The one difference is that only a segment of the audiogram is considered.

Since the transparency assists in determining the position of the "curve of best fit" and the frequency axis at which a deviation joins the main trend, the determination of subscript and superscript values is facilitated.

A transparency is recommended because it reduces the mental computations and simplifies making the judgments necessary for adequate coding. Those using the Deshon classification system will find it worthwhile to prepare such keys to scale with the audiogram forms they are employing.

REFERENCES.

1. GUILD, S. R.: A Method of Classifying Audiograms, THE LARYNGOSCOPE, NOV., 1932.

2. It must be recognized that any classification system rests upon a series of arbitrary rules. The inclusion of each rule must be weighed on the basis of the contribution it makes to the definitiveness of the system.

3. OP. CIT.

4. A transparency for determining major category and "curves of best fit" is described in the Appendix.

5. The sigmoid notation has proven very useful in classifying the audiograms of many patients at Deshon General Hospital. This is particularly true of certain "trauma" cases. It should be noted that audiograms which can be classified under the **s** modifier usually may also be classified in other and more complex ways. When the latter is done, however, the generalized serpentine trend of the curve is obscured.

6. Since in most clinical practice 128 and 8,192 c.p.s. are the extremes in the range of test frequencies, they are not points where two segments of the audiogram converge. Under such circumstances only the notation from 256 to 4,096 c.p.s. are needed.

In situations where mid-octave points are tested, these intermediate points are designated by .5 following the code numeral for the preceding octave frequency. Thus, 2,896 c.p.s. is symbolized as 4.5.

There is a growing tendency in audiometry to use 125 c.p.s. as the base for the octave intervals used in testing. When this is done, the conventions here described can still be applied. The notation for 125 c.p.s. is 0, for 250 it is 1, and so on.

7. The classification system has been used with success in coding hundreds of audiometric curves obtained at Deshon General Hospital. As a matter of fact, the rules incorporated in this paper evolved from practical experience. This experience was gained through having different persons code the same audiograms independently. Discrepancies in the codings were used as the basis for revising the rules. When the present rules are followed carefully, different clinicians assign identical notations with high regularity.

Deshon General Hospital.

BLAST INJURIES OF THE EAR.

MAJOR G. A. HENRY, R.C.A.M.C.

Blast injuries are caused by pressure waves in air or water produced by an explosion. In the present paper only blast air waves are considered. These air waves consist of a sharply rising positive pressure, followed by a slower, gradually diminishing negative or suction phase.

At the onset, blast waves have a greater velocity and amplitude than sound, depending on the chemical properties of the explosive. After traveling some distance and gradually reducing air pressure, the blast wave is converted into a normal sound wave. The ear is the one organ of the body specially equipped as a sound sensory mechanism. While any part of the body may be damaged by blast, it is not surprising to find this organ most frequently injured.

In this paper it is the intention to present the findings and impressions gathered from 292 men sustaining blast ear injuries. Cases presenting direct injuries from projectiles in the region of the aural mechanism, or fracture of the skull, were not included in this series.

These cases were seen during the Battle of Europe at a large hospital part time under canvas and later in buildings. Personnel affected were chiefly Canadian and British, but several nationalities were represented. They came chiefly from infantry and armored units.

CAUSE OF THE BLAST.

It is of interest to study the cause of the blast. In order of frequency, shell fire, mines, bombs, mortars and bazookas were the cause of the explosion. Occasionally it was the man's own gun fired by himself or his crew, while he was in a bad position, which was the cause. Sometimes the information could be elicited that he was at the time suffering from a head cold.

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Tank crews were frequently damaged by bazookas or Piat type of weapon. These projectiles strike the armor, quickly burn their way through, and the damage is entirely done by explosion. Sometimes a shell would explode in a confined space such as a room of a house. Usually only one eardrum was perforated but both ears showed hearing losses of a varying degree.

Many blast injuries occurred when carriers struck a mine. Probably all the members of the crew suffered some blast effects, but frequently only the men on the side striking the mine were seen. The position of the external canal of the ear, in relation to the lines of force of the blast, seemed to be the determining factor in the rupture of the drum.

TINNITUS.

Tinnitus was the most common and by far the most persistent of the symptoms. It occurred in 124 patients in one ear and 48 times in both ears. Some of the patients were able to define it as being about the 2,000-4,000 d.v. level. Usually it lasted for only a few days to a month but in a large minority it persisted continuously for a few months to a year.

It did not seem to occur more frequently in ruptured than with intact eardrums. On several occasions, however, it was noted that the application of a sterile piece of cellophane to the perforation of the drum immediately stopped the tinnitus.

VERTIGO.

Vertigo was not a prominent complaint. Seventy men stated that for a few minutes or perhaps an hour or two they were unsteady on their feet. A few were unconscious for a short time. Only three gave a history of a short acute vestibular upset. Fourteen men complained of continuing occasional attacks of unsteadiness. All at the time of examination had intact drums, normal caloric responses and no evidence of vestibular irritation.

All of the patients, except six, who suffered vertigo at the time of the blast, had a perforation of their eardrums. Of

this six, it was found that four had plugs of wax driven tightly against the tympanic membrane. In this respect it is interesting to note Alexander's[1] explanation of the vertigo. He believes that it is not caused by labyrinthine concussion but by the effect of cold caloric irritation caused by the cold air entering the perforation. He states that it can be re-elicited by alternately placing a bottle filled with ice and a hot water bottle in front of the external canal.

BLEEDING.

A few of the men stated that they found blood in their ear shortly after the blast. Many more gave the information that on the day or two following the accident there was a slight discharge from the ear. They were usually rather vague about the type of discharge.

On examination, however, it was surprising to find how few had evidence of blood in the canal or middle ear. Occasionally evidence of a little bleeding could be seen in the nasopharynx, coming from the Eustachian tube. Bleeding occurred most frequently with tears or smaller drum perforations. The larger perforations gave the appearance of a rough surgical operation of the drum without evidence of gross bleeding or irritation.

HEADACHE AND EAR PAIN.

Headache of the usual frontal, parietal or occipital variety was occasionally a complaint; however, it did not occur more frequently in this group than in a similar number of soldiers without blast ear injuries.

Most men stated that they felt a momentary sharp stabbing pain at the time of the blast. A few complained of pain in and behind the ear for some weeks. A considerable number stated that loud noises and particularly those of a higher pitch were extremely irritating to their ears.

It was difficult to estimate the functional element in this latter complaint; however, it did occur frequently in officers and men who apparently were otherwise extremely stable individuals. To these men it was a real complaint and one

which frequently remained for a matter of one to several months.

TYMPANIC AND MIDDLE EAR DAMAGE.

Slightly more than half the cases of this series, 152, suffered perforation of the ear drum; 114 had a single perforation of one eardrum; 12 more, a double perforation of one drum, and 26 had a single perforation in both tympanic membranes. Hemorrhagic areas of the drum, with or without injection of the blood vessels about the handle of the malleus, were present in 36 cases. Occasionally a linear tear, usually more or less transversely just below the umbo, was seen.

Damage to the tympanic membrane and middle ear seemed to follow fairly regular patterns depending on the pressure force applied. In order of increasing damage, seven fairly clear-cut stages could be recognized:

a. Catarrhal drum and middle ear usually with injection of vessels about the handle of the malleus.

b. Catarrhal drum with a hemorrhagic area in the anteroinferior quadrant.

c. Catarrhal drum, one hemorrhagic area in the anteroinferior quadrant and an added usually somewhat smaller area just superior and posterior to the tip of the umbo. In both *b*. and *c*. the vessels in the region of the handle of the malleus are likely to be injected.

d. Damage of a somewhat greater degree is likely to manifest itself as a linear irregular tear, either in the anteroinferior quadrant or transversely below the tip of the umbo.

e. A single perforation occurs most frequently in the anteroinferior quadrant, usually in the region of the Eustachian tube orifice.

f. When two perforations are present, the second, usually smaller than the first, occurs posteriorly and slightly superior to the tip of the umbo.

g. Gross destruction causes a loss of most of the membrana

tensa and partial skeletinization of one or more of the ossicles. Seldom does there seem to be gross displacement of the ossicles. Rupture of the drum occurs too early to cause damage in this way.

Perforation of Shrapnell's membrane did not occur in any of these cases. This confirms the view of Collier[2] and other observers who state that perforation of the flaccid membrane by blast never occurs. It is of obvious importance from the pension standpoint.

The position of the edges of the perforated drum has been a matter of discussion, College[3] and others, whether they be in inversion or eversion. Most cases at the first examination did not show marked tendencies. It is true some cases showed inversion, somewhat less eversion, but other drums showed inversion and in another part eversion. It was difficult, therefore, to estimate the effects of the primary positive and negative secondary suction waves of the blast.

As previously mentioned, in the larger perforations, the picture of the drum was not unlike that of a crude surgical removal of the perforated area of the drum. There was seldom any evidence of bleeding or in the earlier stages of much inflammation of the drum.

In addition there was usually a marked ischemia of the mucosa of the middle ear which remained dry and pale for nearly a week. Then blood vessels could be seen appearing in the mucosa and a few days later the middle ear mucosa regained its natural color.

EXTERNAL OTITIS.

External otitis was present in one ear canal 20 times and in an additional 22 cases in both ears. It was usually dry or semi-dry and quite annoying. Infected perforations were not included in this group.

In the vast majority of the cases there was no indication that debris driven into the ear canal was the cause; rather, it seemed to be due to the direct action of the blast. There was loss by desquamation of the outer layers of the skin leaving

a semi-raw surface with prominent small blood vessels almost on the surface. This external otitis persisted for some days or weeks until epithelization occurred. It was confined almost entirely to the outer two-thirds of the canal and was occasionally seen in men without tympanic rupture.

TREATMENT.

There are certain generalities of treatment that are common to all blast ear injuries. Realizing that there is a varying degree of functional disturbance in these cases, it is important that as much encouragement as possible should be given. They should not be treated as invalids because hospitalization is frequently necessary in the army to maintain supervision of these patients. Anything that will improve the health of the individual and particularly the nose and nasopharynx will hasten the ear recovery.

For treatment purposes these cases will be divided into three groups. They are: *I* blast injuries without perforation of the drum, *II* those with dry perforations, *III* infected perforations of the tympanic membrane.

GROUP I

Blast injuries of the ear without perforation of the drum, unless accompanied by other wounds, were either not hospitalized or only until any middle ear inflammation had subsided. Ephedrine nasal spray was advised for a short time. They were discharged with a lowered category to a convalescent or holding unit for duty. At the end of a month away from the possibility of blast injury they were again examined and reallocated.

GROUP II.

Men with dry perforations were hospitalized as up patients until their perforation had healed or it became evident that this would be a long process. In that event they were evacuated.

They were instructed to avoid blowing the nose violently and not to get water in their ears. Ephedrine nasal spray was used for a short time.

Local treatment to the ear was studiously avoided. Syringing was never employed. It was very seldom that removal of debris by a sterile cotton-tipped applicator was necessary. The ear canals seemed swept surprisingly clear by the blast. Sulfonamide powder was never employed. A few cases on arrival had already been powdered. It made observation of the progress more difficult, tended to collect and hold moisture, and was a mild irritant. Almost invariably the canal wall, drum and middle ear seemed slightly more inflamed where it was employed.

Cotton wool or a wick dressing was never used to plug the meatus. It was felt that an open meatus allowed evaporation from the middle ear and canal and was an important factor in obtaining a dry ear.

Tears quickly healed. Smaller perforations closed in two to four weeks. Most perforations of one-half or more of the membrana tensa were evacuated when a trial period showed they would require a long time. It seemed unlikely that many of these would ever close.

Occasionally in slow healing perforations a sterile piece of cellophane softened in alcohol was applied on a cotton-tipped applicator to the perforation. Sometimes it seemed to hasten the recovery and was useful in relieving tinnitus.

GROUP III

Most moist perforations exhibited a low grade infection, although occasionally more violent reactions were present. Treatment was essentially that of daily dry cleansing, later followed by boracic in alcohol drops. When progress was slow or unsatisfactory, if bacterial cultures showed strains sensitive to penicillin, it was given, often in combination with sulfadiazine. Nearly all these cases became dry, and if the perforation was small, went on to healing of the drum.

Four cases with particularly violent reactions required simple mastoidectomy in between two to three weeks' time. All had cultures sensitive to penicillin but in spite of this drug and sulfadiazine continued their symptoms. They appeared quite ill, showed persistent temperatures of 100°-103° and

complained of boring mastoid and temporal pain. X-rays were negative. Mastoidectomy showed little evidence of cell destruction, but wide areas of discolored dura with engorged blood vessels, in the posterior and middle fossae and extending up into the temporal area, were uncovered. They all did well postoperatively.

The number of infected perforations was not large. There were 152 men with perforated eardrums, 26 of these with a perforation of both ears, making a total of 178 perforations. Thirty ears, or 17 per cent, became infected. This compares with 42 per cent reported by Silcox and Schenck[4] and 22 per cent by Collins.[5] Some other observers have reported higher percentages on smaller series of cases.

HEARING LOSS.

Let us see what happened to the hearing of the 292 cases, 152 of which suffered perforation of the drum. Hearing was tested by voice, tuning forks 128, 256, 512, 1,024, 2,048, and tuning rods 4,000, 8,000 and 12,000 d.v. An audiometer was not available.

HEARING RESPONSE TO CONVERSATIONAL VOICE ONE MONTH AFTER BLAST.

Residual hearing of C.V. 20′ or more in both ears	193
Residual hearing of C.V. 10′ or less in one ear	64
Residual hearing of C.V. 10′ or less in both ears	14
Residual hearing of C.V. 5′ or less in one ear	44
Residual hearing of C.V. 5′ or less in both ears	6

It quickly became evident that the appearance of the eardrum was no indication of the residual hearing. Slightly more than half the men with hearing C.V. 5′ or less in one ear never suffered a perforation of the tympanic membrane. Conversely, many of the men with a perforation of the drum had hearing of C.V. 20′ a few days after the blast. One began to respect the opinion that rupture of the drum very frequently acted as a safety valve to avoid transmitting greater damage to the inner ear.

In the beginning, nearly all cases had a combination of conductive and perceptive deafness. The greatest hearing improvement occurred in the first 10 days, most of this in the first four days. The majority of cases continued to show

improvement in their perceptive hearing, a few showed gradual deterioration.

Early tuning fork tests showed a loss throughout the range 128-12,000 cycles per second to air conduction with some increased loss in the upper tones, 2,000-12,000 cycles. This higher tone loss became more evident if the damage were severe. During the initial improvement the greatest recovery was evident in the range 128-2,000 cycles, with a lesser degree of recovery in the higher notes.

Taking the series as a whole, one would expect that about two-thirds of the group would later suffer no noticeable defect. Of the remaining one-third, the majority would be aware of some deterioration of hearing in one ear. A few will require the help of a hearing aid. There will unquestionably be a smaller percentage that will require training in lip-reading.

SUMMARY 292 CASES OF BLAST EAR INJURY.

Tinnitus present in one ear	124	Both ears	48
Vertigo	70		
Perforation of drum one ear	152	Both ears	26
Perforation of Shrapnell's membrane	0		
Total number perforated drums	178		
Infected perforations	30	17 per cent	
Perforation still present one month one ear	50	Both ears	6
Simple mastoidectomies	4		
External otitis one ear	20	Both ears	22
Reduction hearing 1 month C.V. 10′ or less one ear	64	Both ears	14
Reduction hearing 1 month C.V. 5′ or less one ear	44	Both ears	6

A series of 292 men suffering from blast injuries of the ear has been presented. The important signs, symptoms and means of treatment have been discussed. Some observations not frequently or previously discussed on external otitis, types of blast perforation and ischemia of the middle ear following blast injury have been noted.

It seemed likely that about two-thirds of these men would recover completely. Others would unquestionably be inconvenienced by loss of hearing in one ear. A smaller group will require the help of a hearing aid. Unfortunately a few will have so much loss of hearing that they will require instruction in lip-reading.

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MISSISSIPPI VALLEY MEDICAL SOCIETY TO MEET IN ST. LOUIS, SEPT. 25, 26, 27, 1946.

The eleventh annual meeting of the Mississippi Valley Medical Society will be held Sept. 25, 26, 27, 1946, at the Hotel Jefferson in St. Louis. Due to the fact that no meeting was held in 1945, all the officers of the society have been retained for another year. These include the president, Dr. Grayson L. Carroll, of St. Louis; president-elect, Dr. Walter A. Sternberg, of Mt. Pleasant, Iowa; first vice-president, Dr. Louis H. Jorstad, of St. Louis; second vice-president, Dr. Elmer E. Nystrom, Peoria, Ill; third vice-president, Dr. E. J. Lessenger, New London, Iowa; secretary-treasurer, Dr. Harold Swanberg, Quincy, Ill.

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